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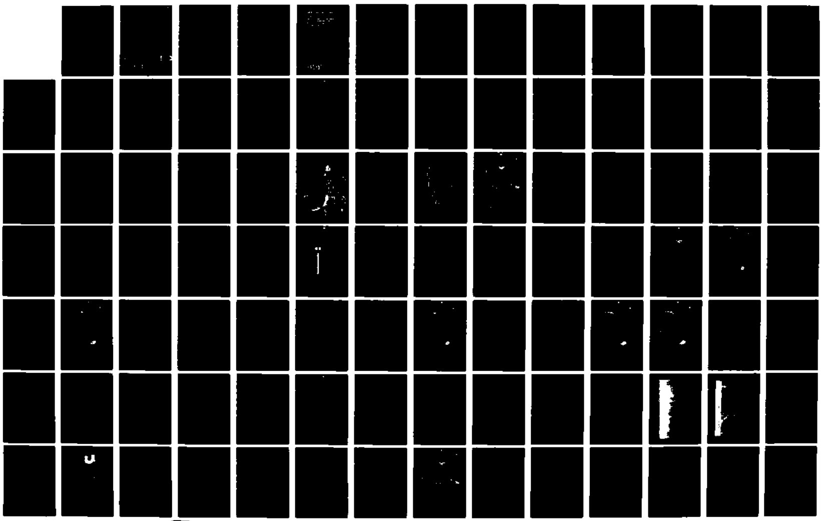

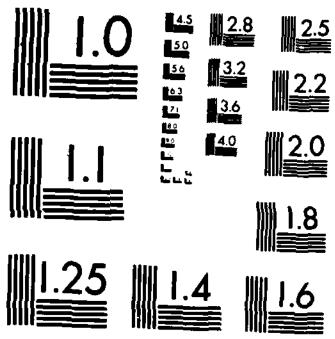

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Installation Restoration Program

Final Report
Phase II - Problem Confirmation and Quantification Study
Griffiss Air Force Base
Rome, New York

Prepared For:

United States Air Force
Occupational and Environmenta Health Laboratory (CEHL)
Brooks Air Force Base, Texas

December 1982

DISTRIBUTION STATEMENT A
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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A125958	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Installation Restoration Program Final Report Phase II - Problem Confirmation & Qualification Study Griffiss AFB; Rome, NY		5. TYPE OF REPORT & PERIOD COVERED Final Report December 1982
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Roy F. Weston, Inc.		8. CONTRACT OR GRANT NUMBER(s) Task Order #0005 of Air Force Contract No. F33615-80-D-4006
9. PERFORMING ORGANIZATION NAME AND ADDRESS Roy F. Weston, Inc. Weston Way West Chester, PA 19380		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS HQ SAC/SGPB Offutt AFB, NE 68113		12. REPORT DATE December 1982
		13. NUMBER OF PAGES 210
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclas
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE -

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Environmental Quality
Water Pollution
Installation Restoration Program

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A sophisticated study was accomplished at Griffiss AFB, NY, to quantify the degree of adverse environmental quality impact, if any, caused by past domestic and hazardous wastes management practices. The final report reveals minimal adverse impact. Recommendations for proper closure actions at two sanitary landfills as well as actions addressing two facets of past hazardous waste practices are included.

Installation Restoration Program

Final Report
Phase II - Problem Confirmation and Quantification Study
Griffiss Air Force Base
Rome, New York

Prepared For:

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DESIGNERS CONSULTANTS

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EXECUTIVE SUMMARY

INTRODUCTION

Roy F. Weston, Inc. (WESTON) was retained by the United States Air Force Occupational and Environmental Health Laboratory (OEHL) on 23 September 1981 to conduct a Phase II Problem Confirmation and Quantification field investigation at Griffiss Air Force Base. This work was done under Task Order No. 0005 of Air Force Contract No. F33615-80-D-4006.

Department of Defense (DoD) policy was directed by Defense Environmental Quality Program Policy Memorandum 81-5 dated 11 December 1981 and implemented by Air Force message dated 21 January 1982 as a positive action to ensure compliance of military installations with existing environmental regulations. DEQPPM 81-5 reissued and amplified all previous directives and memoranda on the Installation Restoration Program. The purpose of DoD policy is to identify and fully evaluate suspected problems associated with past hazardous material disposal sites on DoD facilities, control the migration of hazardous contamination from such facilities, and contol hazards to health and welfare that may have resulted from these past operations.

To implement the DoD policy, a four-phase Installation Restoration Program has been directed. Phase I, the records search (not a part of this contract), is the identification of potential problems. Phase II consists of follow-on field work as determined from Phase I. Phase IIa consists of a preliminary survey to confirm or rule out the presence or migration of contaminants. If the Phase IIa work confirms the presence or migration of contaminants, then Phase IIb field work would be conducted to determine the extent and magnitude of the contaminant migration. Phase III (not part of this contract), consists of a technology base development study to support the development of project plans for controlling migration or restoring the installation. Phase IV (not part of this contract) includes those efforts which are required to control identified hazardous conditions.

The Phase IIa preliminary survey portion of this work was conducted at Griffiss Air Force Base in August of 1981. Phase IIb field investigations were conducted between September 1981, and September 1982. The field investigation evaluated five landfills, a dry well and a PCB handling area. Topographic analysis, aerial photo analysis, earth resistivity surveys, and a limited

ground penetrating radar (GPR) survey were accomplished. Fourteen groundwater monitor wells were constructed and sampled. Four surface water stations were established for flow measurements and water quality sampling. Soil boring and soil grab samples were analyzed. Aquifer characteristics tests were accomplished on four wells. Concept engineering analysis of potentially applicable remedial actions was accomplished for all sites evaluated.

MAJOR FINDINGS

Low levels of groundwater contamination were detected in the vicinity of Landfill No. 1, although no evidence was obtained documenting off-base migration of landfill contaminants. The leachate seep at Landfill No. 1 is the surface expression of the only "plume" of contaminants found to be migrating off the landfill site. The limited distribution, low concentrations and limited range of contaminant types in this "plume" suggest that the off-site contamination southwest of Landfill No. 1 is an isolated occurrence. The presence of a low level of a volatile organic (ethylbenzene) compound in this "plume", but its absence in the landfill leachate, supports the isolated nature of the contamination. Additional groundwater quality monitoring is needed to verify these findings. No potable water supply wells occur within one mile downgradient of Landfill No. 1. Leachate is discharging to Six Mile Creek at very low rates, appears to be non-toxic to vegetation, undergoes large instantaneous dilutions in the creek, and has no detectable impact upon surface water quality where Six Mile Creek leaves the base. Although Landfill No. 1 was closed in 1973 in accordance with then-applicable regulations, several remedial actions are appropriate in order to reduce the volume of leachate generated by Landfill No. 1.

No leachate was detected to be present or migrating in the vicinity of Landfill No. 2, although two additional monitoring wells will be needed to verify this finding. Since Landfill No. 2 is the most recently used waste disposal site, and is only partially closed, it has the highest probability of generating new leachate in the future. Waste disposal activities at Landfill No. 2 should be discontinued, and the site will require closure in accordance with regulations of the New York Department of Environmental Conservation.

No leachate was detected to be present or migrating in the vicinity of Landfill No. 5, 6 or 7. Due to the ages of these landfills, none are expected to generate leachate in the future. No further evaluative or remedial actions are appropriate at these three sites.

No pesticides were detected in groundwater adjacent to the dry well at the Entomology Laboratory, Building 301. Generic remedial actions are appropriate to all dry well disposal, including discontinuing waste disposal in dry wells and establishing controlled usage of drains leading to dry wells.

Soil PCB contamination in the vicinity of the High Power Laboratory, Building 112, appears to be limited to areas "d" and "e" adjacent to the building. Roof material near the leaking transformer is contaminated with PCB at levels in excess of the U.S. EPA action levels. All roofing and soils contaminated with PCB at levels in excess of the 50 mg/kg Action Level should be removed and properly disposed of in either an Annex I incinerator or an Annex II chemical waste landfill.

None of the former waste disposal sites at Griffiss Air Force Base which were evaluated under this Phase II Problem Confirmation and Quantificaton field investigation should be of major environmental concern.

RECOMMENDATIONS

- Additional groundwater quality monitoring should be done in the vicinity of Landfill No. 1 to verify the limited nature and distribution of leachate from that site. As a minimum, monitor wells W1, W5, W7 and P2 should be included in this program.
- The minimal action options of 1) cleanup of all exposed wastes, and 2) backfilling of surface depressions, compacting and, regrading, should be implemented at Landfill No. 1.
- Additional actions for Landfill No. 1, such as installation of a clay and topsoil cover over non-reforested areas, and revegetation of this cover, should be considered pending results of the additional groundwater quality monitoring recommended above.
- Two additional monitor wells should be constructed at Landfill No. 2.
- All waste disposal at Landfill No. 2 should be terminated as soon as alternative disposal arrangements can be made.

- Upon termination of all waste disposal activities at Landfill No. 2, the site should be closed in accordance with regulations of the New York State Department of Environmental Conservation.

- No further actions are recommended for Landfill No. 5, 6 or 7.

- Use of dry wells as a waste disposal mechanism should be discontinued. Drains leading to dry wells should be either disconnected, plugged or have a controlled usage established.

- The leaking transformer at Building 112 should be repaired as soon as possible.

- As soon as possible after repair of the leaking transformer, soils and roof materials at Building 112 having PCB concentrations in excess of the 50 mg/kg Action Level should be removed for proper disposal in either an Annex I incinerator or an Annex II chemical waste landfill.

SECTION 1

INTRODUCTION

1.1 BACKGROUND

The discharge, disposal and storage of solid wastes into or on the land surface is regulated by both state and federal laws. The key legislation is the Resource Conservation and Recovery Act of 1976 (RCRA), which was promulgated to regulate the generation, transportation, treatment, storage and disposal of hazardous wastes; to phase out the use of open dumps for disposal of solid wastes; and to promote the conservation of natural resources through the management, reuse or recovery of solid and hazardous waste. Regulations and implementation instructions of RCRA are continuing to be developed by the U.S. Environmental Protection Agency (USEPA).

Under RCRA Section 3012 (PL-96-482, October 21, 1980), each state is required to inventory all past and present hazardous waste disposal sites. Section 6003 of RCRA requires federal agencies to assist USEPA and make available all requested information on past disposal practices. It is the intent of the Department of Defense (DOD) to comply fully with these as well as other requirements of RCRA.

1.2 AUTHORITY

Simultaneous with the passage of RCRA, the DOD devised a comprehensive Installation Restoration Program (IRP). The purpose of the IRP is to assess and control migration of environmental contamination which may have resulted from past DOD operations. In response to RCRA, and in anticipation of the Comprehensive Environmental Response Compensation and Liability Act of 1980 (Superfund), the DOD issued directive DEQPPM 80-6 (Defense Environmental Quality Program Policy Manual, June 1980) requiring identification and evaluation of past hazardous waste disposal sites on DOD agency reservations. The U.S. Air Force implemented DEQPPM 80-6 by message in December 1980. The program was revised by DEQPPM 81-5 issued in January 1982.

1.3 INSTALLATION RESTORATION PROGRAM

The Installation Restoration Program has been developed as a four-phased program as follows:

Phase I - Problem Identification/Records Search

Phase II - Problem Confirmation and Quantification

Phase III - Technology Base Development

Phase IV - Corrective Action

The Phase I Records Search activity is intended to compile all identifiable data concerning past waste disposal practices at each base. From this compilation, then, an assessment may be made of the probability of the existence of environmental contamination problems, and their potential locations, extents and magnitudes. All of the potential problem areas are ranked on the basis of a standard evaluation system (Hazard Assessment Rating Methodology, or HARM) which is applied to all base record searches. The Phase II, (Problem Confirmation and Quantification) is initiated at a base if the problem ranking (HARM scores) for sites at that base indicate a high priority based upon a high probability of significant environmental contamination. Phase II is a problem definition type of field-oriented study in which the magnitude and extent of environmental contamination is explored to confirm Phase I results and then quantitatively evaluated. A small amount of concept engineering is also done during Phase II, in order to provide the Air Force with a list of viable remedial engineering options for consideration. Phase III, should one be required, involves the development of appropriate technology and the complete engineering design of the corrective action option selected for implementation by the Air Force. Phase IV involves the construction, operation and maintenance of the corrective action option designed under Phase III.

1.4 IRP PHASE I AT GRIFFISS AIR FORCE BASE

The Phase I Records Search for Griffiss Air Force Base (GAFB) was conducted by the firm of Engineering-Science, located in Atlanta, Georgia. The on-site portion of the work was done from 27 April to 1 May 1981. Data evaluation and report preparation continued through June, 1981, and the final report was issued on 14

July 1981. The Phase I work specifically addressed the following questions:

- What hazardous materials have been generated on the base?
- How have wastes been managed?
- Was the waste management procedure used adequate to immobilize, contain, treat, destroy or detoxify the waste material?
- By what routes or means, if any, can the wastes migrate from the disposal site?
- What effects could occur, or might have occurred, through the discharge or release of the wastes?

The findings and conclusions made by Engineering-Science in the Phase I Report were as follows:

1. Landfill Areas

   a. Landfill No. 1 creates the greatest potential for off-site migration of contaminants. Surface contamination of Six Mile Creek by leachate from the landfill has been identified and groundwater contamination may also be occurring.

   b. Other Landfills (No. 2, 5, 6 and 7) may present potential contamination problems due to construction techniques used (no liner), location (wetland areas, permeable soils), unknown nature of waste materials (incomplete records).

2. Drywells

   a. Drywells at Buildings 117, 3, 301, 225, and 219 (ranked in descending priority) have been used in the past to dispose of hazardous materials which may have resulted in ground-water contamination.

3. Spill Areas

   a. The Floyd PCB spill area, the Lindane spill area (former Entomology storage building) and the Building 112 PCB-handling area exhibit a potential for contamination of ground water.

   b. The storage area for liquid hazardous waste (Lot 69) has had small spills in the past and does not provide containment (seepage), or security (no fence).

4. Water Wells

   a. On-base water wells could become contaminated by leachate production from the landfills.

Table 1 contains the Engineering-Science priority ranking of waste Disposal Sites at Griffiss Air Force Base. Based upon this priority ranking, Engineering-Science made several recommendations for work which needed to be addressed in the Phase II field investigation. These recommendations included:

First Priority

Ground-water and surface water monitoring should be performed at Landfill No. 1. There should be a minimum of one well up-gradient and twc wells down-gradient. At a minimum, Interim Primary Drinking Water Standards, Priority Pollutants and TOC analyses should be carried out.

Second Priority

Ground-water and surface water monitoring should be performed on Landfill No. 2 and 7 as well, with similar analyses being carried out.

Other Recommendations

1. Initiate temporary remedial measures for landfill closure at Landfill No. 1 and No.2. Improve cover at both sites (grade to eliminate ponding, provide plant cover) and construct leachate collection sump for surface runoff at Landfill No. 1.

Table 1

Phase I Site Evaluation HARM Scores
(Modified From Phase I, Records Search Report)

Rank	Site Name	Initial HARM Score	Revised HARM Score*
1	Landfill No. 1	81	72
2	Landfill No. 2	75	55
3	Landfill No. 7	68	53
4	Bulk Fuel Storage Area	58	51
5	Lindane Spill at Former Entomology Storage Building	57	46
6	Yellow Submarine Holding Tank, Bldg. 101	56	46
7	Landfill No. 5	55	44
8	PCB Handling Area, Building 112	53	45
(9)	Landfill No. 6	52	50
(9)	Drywell, Steam Plant, Building 117	52	43
11	Drywell, Building 3	51	47
12	Drywell, Entomology, Building 301	50	50
13	Two Drywells, Building 255	49	43
(14)	General Chlordane Application	46	52
(14)	Drywell, Building 219	46	36
(14)	PCB Spill at Floyd	46	47
17	Hazardous Waste Storage Area, Lot 69	38	47
18	Waste Oil Storage Area, Building 101	36	31
19	PCB Transformer Leak, Building 112	32	34

*HARM scores are based upon the IRP Hazard Assessment Rating Methodology. Revised scores were necessitated by revision of the Methodology promulgated after publication of the GAFB PHASE I Records Search Report.

2. Discontinue the use of dry wells for disposal of hazardous material.

3. Sample soil from the Building 112 PCB handling area and analyze for PCB concentration.

4. Perform periodic analyses (Interim Primary Drinking Water Standards, Priority Pollutants and TOC) on water produced by on-base water wells.

SECTION 2

PURPOSE AND SCOPE

2.1 GENERAL

Roy F. Weston, Inc. (WESTON) and other contractors are currently under a basic ordering agreement (BOA) contract with the United States Air Force, to provide geological, analytical and concept engineering expertise in the conduct of Phase II, Problem confirmation and Quantification, at selected Air Force facilities. WESTON's contract, number F33615-80-D-4006, has been in effect since 20 July 1981. Task Orders are initiated under this contract when the Air Force Phase II IRP Program Manager identifies a requirement for Phase II services. A typical task order sequence of events proceeds as follows:

- The Air Force Phase II IRP Program Manager identifies a base for PHASE II Problem Confirmation and Quantification work, and selects the appropriate BOA contractor to conduct Phase II.
- A Pre-Survey task order is initiated, under which a contract team proceeds to the identified site, conducts a pre-survey inspection, and submits a written report of the visit. This report includes a proposed scope of work for conducting the Phase II field investigation.
- The Phase II IRP Program Manager reviews the proposed scope of work, makes alterations as needed, and issues a Task Order for execution of a formal Phase II.
- Phase II is conducted and duly reported.

Based upon the priority ranking of waste disposal sites shown in Table 1, upon the recommendations made by Engineering-Science, and upon other considerations, the Air Force Phase II IRP Program Manager identified Griffiss Air Force Base as one of the Air Force installations requiring Phase II Confirmation and Quantification. On 4 September 1981 the Air Force Phase II IRP Program Manager initiated Task Order 0002 under the BOA Contract, directing that WESTON conduct a Pre-Survey inspection of Griffiss Air Force Base (GAFB), and prepare a detailed work plan for conducting a Phase II, Problem Confirmation and Quantification there.

2.2 PRE-SURVEY INSPECTION FINDINGS

WESTON's Pre-Survey Inspection included visits to each of the positively identifed ranked sites at GAFB with initial HARM scores higher than 50. Revised HARM scores were not available at an early enough date to be used in planning the Phase II Scope of Work. In some cases the locations of ranked sites have never been pinpointed, and so no inspection was possible. WESTON was in fundamental agreement with the Phase II actions recommended in the Phase I report. Deviations from those recommended actions were usually on the side of a more in-depth examination of a suspected problem site. Several sites listed in Table 1, and having initial HARM scores higher than 50 were not evaluated under Phase II, as follows:

- Bulk Fuel Storage Area - No major spills or leaks had been documented, and the site is an active, operational facility not under the purview of the IRP. No evaluative actions were conducted.

- Lindane Spill at Former Entomology Storage Building - The location of the spill has never been indentified, so that no evaluative actions were possible.

- Yellow Submarine Holding Tank, Bldg. 101 - This site is part of the on-going operation of the metal plating shop, and is not under the purview of the IRP. No evaluative actions were conducted.

- Drywells, Buildings 2, 117 and 225 - These sites had either no known locations, or were located beneath facilities where evaluation was not possible. The drywell at the Entomology Laboratory, Building 301, was selected as generically typical and was evaluated as a surrogate for the other drywells.

Of the four other recommendations contained in the Phase I Report, the recommendations for discontinuation of use of drywells and for sampling and analysis of water suppuly wells were both implemented by GAFB personnel. The recommendation for sampling and analysis of PCB concentrations at Building 112 was adopted. The recommendation for temporary remedial measures at landfills 1 and 2 was postponed pending the results of concept engineering analysis of these two sites to be accomplished under Phase II.

The Pre-Survey inspection was conducted on 25 August 1981 by a WESTON team, and the final report containing the proposed detailed work plan was submitted to the Phase II IRP Program Manager on 1 September 1981. The Program Manager reviewed the proposed work scope, and on 23 September 1981 Task Order 0005 to the BOA contract was issued, directing WESTON to proceed with implementation of the work plan for a field investigation at Griffiss Air Force Base.

2.3 SCOPE OF WORK

The Scope of Work for the Field Investigation at Griffiss Air Force Base, as specified by Task Order 0005 to Air Force Contract F33615-80-D-4006, included the following items:

2.3.1 Purpose

The purpose of this task is to determine the extent and magnitude of any environmental contamination which has resulted from previous waste disposal practices at Griffiss Air Force Base, Rome, New York; to identify possible actions to mitigate adverse environmental effects of existing contamination problems; to suggest potential ways of restoring the environment to as near a normal level as is practical; and, to suggest a future environmental monitoring program, if necessary, to document environmental conditions at Griffiss Air Force Base.

2.3.2 Landfill No. 1

- Conduct a fixed-depth profile, earth-resistivity survey to optimize monitoring well locations.
- Install four groundwater monitoring wells (approximately 35 feet deep), one upgradient and three downgradient of the landfill site. Wells will be constructed in accordance with United States Army Toxic and Hazardous Materials Agency (USATHAMA) specifications and description provided in the presurvey report.
- Conduct aquifer testing on one well and monitor all wells in accordance with protocol proposed in the presurvey report.
- Collect four water samples (one from each well) in accordance with Environmental Protection Agency (USEPA) Standards and United States Geological Survey (USGS) methods for collection and preservation

(See Para. 4.2.6.1). A second round of samples for specific ions and organic pollutants would be collected within three weeks of the first sampling round to determine baseline information on specific contaminants.

- To determine the total area of leachate migration at Landfill No. 1, the following steps should be taken:

  a. Install five additional groundwater monitoring wells at locations selected on the basis of preliminary findings. Two of these wells should be completed to a depth of 70 feet in order to determine data on contaminant stratification. Wells will be installed in the manner previously discussed for initial investigations at this site.

  b. Collection and analyses of groundwater samples, as required, from the five confirmatory wells, and analyses for specific organics, heavy metals, specific anions, oil and grease, pH, and specific conductance.

- Prepare a field investigations report delineating the nature and magnitude of contaminants at the site, and the potential ways of mitigating, reducing, or eliminating the source of environmental contamination.

2.3.3 Landfills No. 2, 5, 6 and 7

- Conduct earth-resistivity surveys at Landfills No. 2, 5, 6 and 7 to determine whether or not subsurface contaminant plumes are present at these locations.

- Install one groundwater monitoring well, approximately 35 feet deep, downgradient of each landfill site at which earth-resistivity surveys indicate the presence of subsurface contaminant plumes. Wells will be installed, surveyed, and sampled in the manner discussed in the field program for Landfill No. 1.

- Collect ground water samples from each monitoring well and analyze for the presence of priority pollutants, specific organics, heavy metals, specific anions, oil and grease, pH, and specific conductance.

2.3.4 Dry Well Evaluation

- Dry wells located on Griffiss Air Force Base should be evaluated. Those locations suspected of having a high potential for groundwater contamination should have earth-resistivity surveys conducted to confirm or deny the presence of plumes. As a minimum, an earth-resistivity evaluation should be conducted in the vicinity of the dry well adjacent to the Entomology Laboratory (Building 301).

- If a contaminant plume is located near Building 301, one groundwater monitoring well, approximately 35 deep, should be installed downgradient of the dry well in question. A water sample should be collected from the well and analyzed for pesticides and herbicides.

- If groundwater monitoring wells are not required to evaluate leachate plumes at Landfills No. 2, 5, 6, or 7, the proposed monitoring wells can be relocated and sampled to evaluate contamination plumes from other dry wells at Griffiss Air Force Base. If funding for needed wells is unavailable, this requirement for further monitoring should be included in preliminary and final reports.

2.3.5 Potential PCB Contamination Sites

- Potential PCB contamination areas should be evaluated in the manner proposed in the presurvey report. At a minimum, three locations in the PCB handling area, Building 112, and two other locations determined by priority ranking, should be sampled at the surface from a depth of three feet and analyzed for PCB or other appropriate chemical constituents.

2.3.6 Report Preparation

Prepare a report delineating the findings of this field investigation. This report should include formal recommendations for additional field investigations at Griffiss Air Force Base. To the maximum extent possible, based on the data generated in this effort, the magnitude and extent of environmental contamination should be reported. If possible, recommendations for actions necessary to clean up observed contamination, or to mitigate the effect of observed contamination, should be included. Recommendations for future environmental monitoring should also be included.

2.4 MODIFICATIONS TO INITIAL WORK SCOPE

Upon completion of the Problem Confirmation Stage of Phase II it became apparent that several modifications to the initial scope of work were appropriate. Those modifications were made in order to allow the Phase II to adjust goals as new data became available. The modifications agreed upon included:

- The two deep monitor wells, among the five Quantification Stage wells, were deleted since bedrock at Landfill No. 1 was found to be shallower than expected based upon the Phase I Report. Five shallow Quantification Stage wells were installed.
- Slug testing on several wells was substituted for a pump test on one well due to the thin saturated thickness of unconsolidated deposits and to the distances between wells at Landfill No. 1.
- A restricted list of analytes for Quantification Stage analysis was selected (see Para. 5.3.5).
- Surface water quality monitoring on Six Mile Creek near Landfill No. 1 was added in response to Problem Confirmation Stage analysis of leachate from Landfill No. 1.

2.5 PURPOSE

The purpose of this report is to document WESTON's activities and findings in accomplishing Phase II Problem Confirmation and Quantification at Griffiss Air Force Base.

WESTON

2.6 KEY PHASE II PERSONNEL

WESTON assigned the following personnel to key roles in this project:

- Mr. Peter J. Marks, Program Director: Corporate Vice President and Manager of Laboratory Services, M.S. in Environmental Science, 18 years of experience in laboratory analysis and applied environmental sciences.

- Mr. Frederick Bopp III, Project Manager: Ph.D. in Geological Sciences, Registered Professional Geologist, over seven years of experience in geochemistry and hydrogeology.

- Mr. Richard C. Johnson, Project Geologist: M.S. in Geological Sciences, over five years of experience in hydrogeology and geotechnical engineering.

- Mr. Michael H. Corbin, Project Engineer: M.S. in Mechanical Engineering, Registered Professional Engineer, over 10 years of experience in landfill design and operation and in evaluation of hazardous waste disposal sites.

- Mr. Walter M. Leis, Geotechnical Quality Assurance Officer: Corporate Vice President and Manager of the Geosciences Department, M.S. in Geological Sciences, Registered Professional Geologist, over 10 years of experience in hydrogeology and applied geological sciences.

- Mr. James S. Smith, Laboratory Quality Assurance Officer: Ph.D. in Chemistry, over 16 years of experience in laboratory analysis.

Brief professional profiles of these and other project team members are in Appendix A.

SECTION 3

SITE DESCRIPTION

3.1 GENERAL

Griffiss Air Force Base occupies approximately 3900 acres of land located within the broad, relatively flat lowlands of the Mohawk River Valley in central New York State. The nearest cities are Rome, approximately two miles from the base boundary on the southwest, and Utica approximately 16 miles to the southeast. The area of the base and its surrounding environs lie entirely within the Rome 7.5 minute topographic quadrangle map of the United States Geological Survey. Figure 1 is an index map showing the location of Griffiss Air Force Base.

3.2 REGIONAL GEOLOGIC SETTING

Griffiss Air Force Base (Griffiss) is located at the eastern edge of the Central Lowland Physiographic Province of the northeastern United States. To the east of this area is a roughly north-south trending structure known as the Adirondack Arch, which is the structural divide between the Central Lowlands on the west and the Adirondack Mountains and the Appalachian Plateau to the northeast and southeast, respectively. Bedrock at Griffiss is the Utica Shale of Ordovician age. The Utica is a relatively soft, black to dark grey calcareous shale which was derived by erosion of sediments from the newly uplifted Catskill and Taconic Mountains to the east and southeast. It is nearly flat-lying in the Griffiss area, with bedding a few miles' distance from Griffiss dipping 5 or 6 degrees to the southwest. The nearest either hypothesized or mapped fault is about six miles east of Griffiss, and it trends north-south, roughly parallelling the Adirondack Arch further to the east. Lineament analysis in the area indicates that a linear, north--south feature appears to control the north-to-south flow path of the Mohawk River to the north and west of Griffiss, although the precise structural nature of that lineation is presently unknown. The bedrock Utica Shale is known to be jointed in the area. Most joint planes are nearly vertical, and the dominant joint set trends to the east and southeast along the trend of the Mohawk Valley east of Rome.

The Griffiss area is known to have been glaciated at least once during the Pleistocene Epoch. As a result of this glaciation

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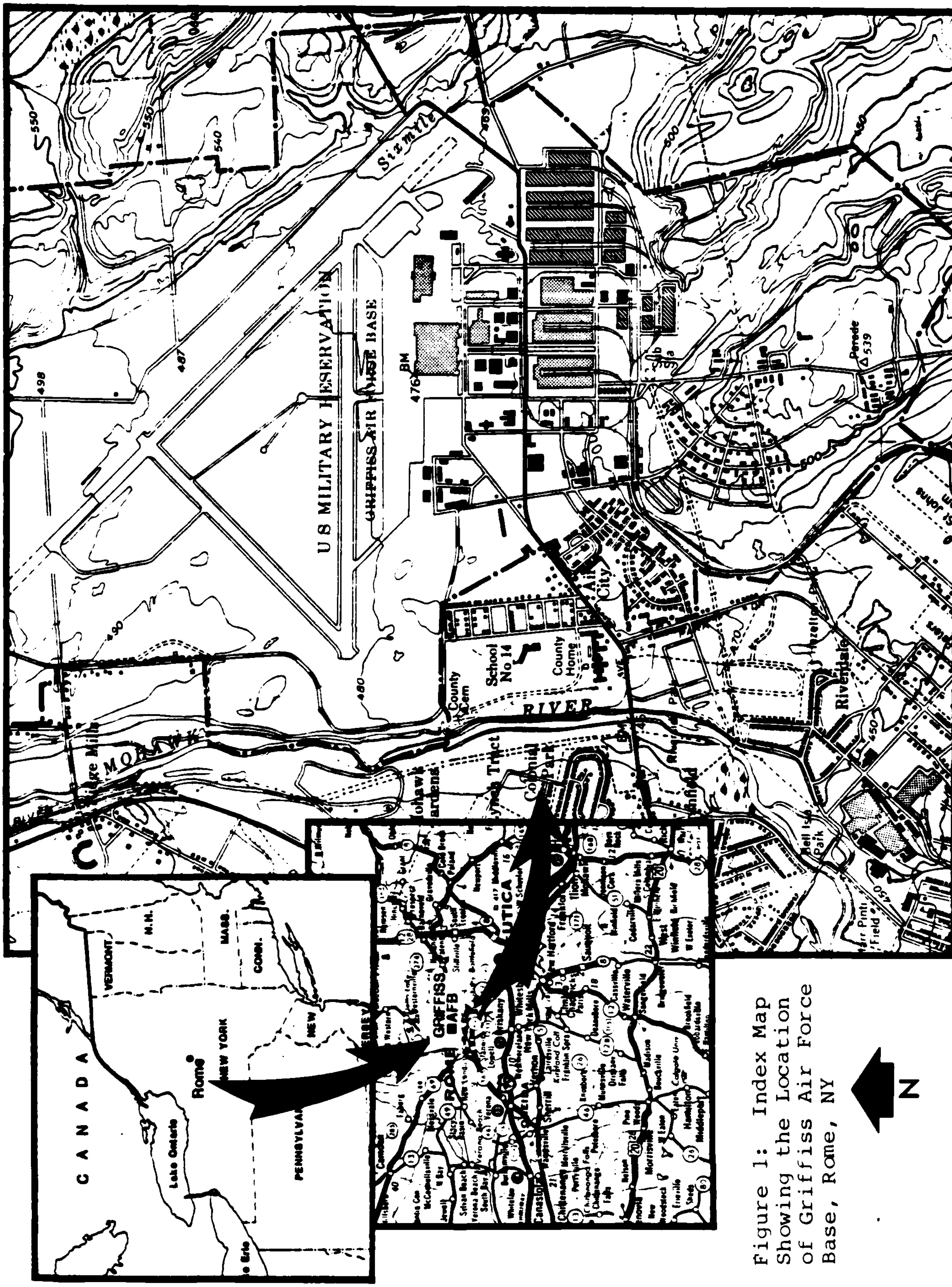

Figure 1: Index Map Showing the Location of Griffiss Air Force Base, Rome, NY

the surface of the Utica Shale has been gouged and scoured by ice action into a gently irregular surface. Two major types of unconsolidated deposits are known to overly the Utica Shale unconformably, and each of these deposits owes its origin to the presence of glaciers nearby. The deposits immediately overlying the Utica Shale are Pleistocene age lacustrine and glacio--fluvial fine sands, silty sands, silts and sandy clays which were formed in association with the now-extinct glacial Lake Iroquois. Overlying these deposits, and in some areas laterally equivalent to them, are more recent alluvial and glacio-deltaic deposits of medium-to coarse-grained sands and gravels formed in association with outwash of sediments from retreating glaciers. The most recent deposits are small in lateral extent, and represent fluvial reworking of previously-deposited sediments. At Griffiss, the few topographic highs present are capped by the coarse-grained alluvial and glacio-deltaic deposits, with the lacustrine fine grained materials dominating the lower lying areas. Figure 2 is a map summarizing the surficial geology at Griffiss.

3.3 TOPOGRAPHY AND SURFACE DRAINAGE

The topography of Griffiss is gently rolling to generally flat. The low relief on the base is typical of the region west of the Adirondack Arch. Topography is controlled dominantly by erosion patterns which have been superimposed upon the unconsolidated sedimentary deposits comprising the surficial geology shown in Figure 2. Elevations at Griffiss average about 500 feet above a mean sea level datum (MSL), and rarely depart from that average by more than 30 feet. Most of the base north of Floyd Avenue has been subjected to cut and fill operations during construction of the airfield portion of the base, and in that area local relief rarely exceeds 10 feet.

The main surface drainage on the base is comprised of two creeks: Three Mile Creek begins in the south-central portion of the base, flows generally southeasterly past much of the residential portion of the base, and discharges off-base into the New York State Barge Canal; Six Mile Creek enters the base at the North Boundary, flows generally southeasterly across most of the northeastern perimeter of the base, continues southeasterly through an underground culvert under the main runway, and discharges off the southeasterly base boundary into the New York State Barge Canal. The gently undulating topography of the area accounts, at least in part, for this relatively minimal surface water drainage pattern. Figure 3 is an index map of Griffiss which shows the locations of these two creeks.

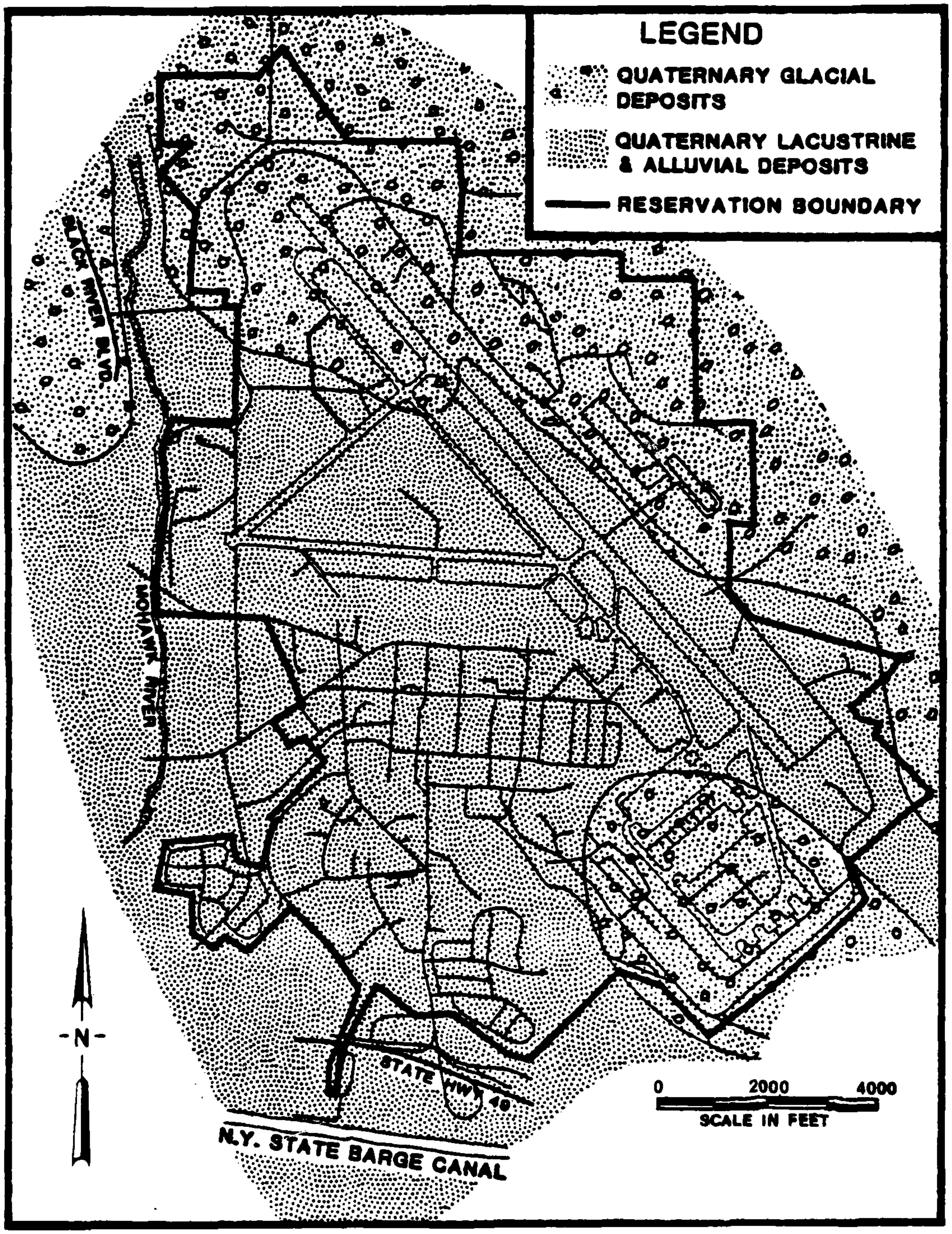

Figure 2: Map of Surficial Geology at Griffiss Air Force Base, Rome, NY

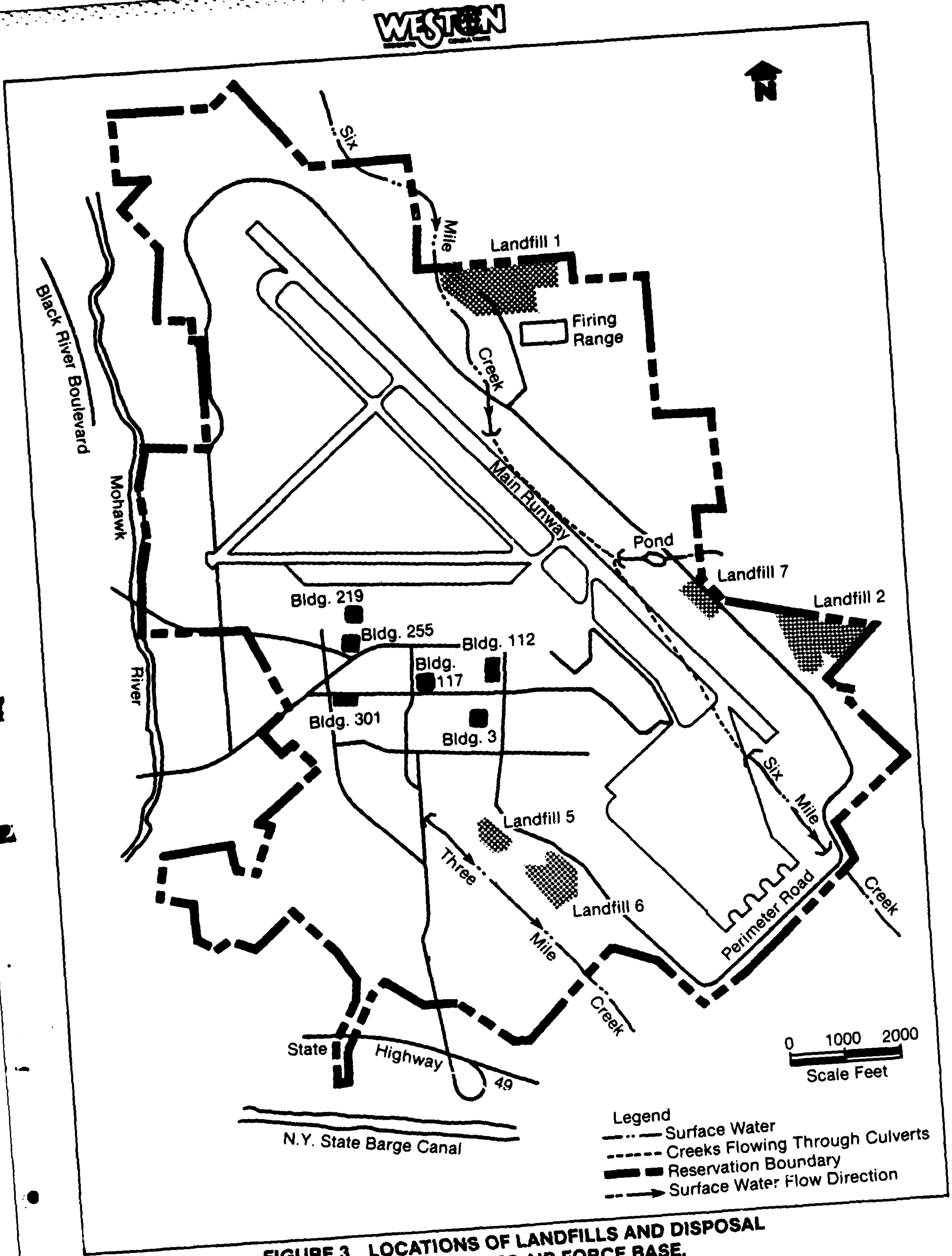

FIGURE 3 LOCATIONS OF LANDFILLS AND DISPOSAL SITES, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

3.4 HYDROGEOLOGY

Most of the potable waters supplied to consumers via municipal systems in the Mohawk Valley are derived from surface waters. By some estimates surface waters may supply as much as 95 percent of all municipal waters consumed in the region. Groundwaters appear to be used dominantly for domestic supplies and farm irrigation, and only in areas outlying municipal distribution systems. Three main units comprise the readily available groundwater aquifers at Griffiss, and these are the same three units previously discussed under paragraph 3.2.

- Quaternary Age lacustrine and alluvial deposits comprise an unconsolidated, unconfined aquifer made up of primarily fine-grained sediment. These deposits vary in thickness from 10 to 150 feet in the area. Wells screened into this unit average 68 feet in depth near Griffiss. The well yields range from 2 to 40 gallons per minute, averaging 11 gpm. Water derived from this unit is of variable quality, and is usually hard.

- Quaternary Age glacial deposits make up an unconsolidated, unconfined aquifer comprised of primarily coarse-grained sediments. These deposits vary in thickness from 10 to 140 feet in the area. Wells screened into this unit average 67 feet in depth near Griffiss. This is the most productive aquifer of the region, with typical yields varying from 10 to 290 gallons per minute, averaging 80 gpm. The water is reported to be of good quality.

- Utica shale comprises a consolidated, usually unconfined aquifer containing water in weathered upper zones, in joints, bedding planes and in secondary fissures. This unit may function under confined (artesian) conditions locally. The unit ranges in thickness in the region from 300 to 400 feet and typical yields range from 0.5 to 48 gallons per minute, averaging 7.5 gpm. Water supplies are normally drawn from upper reaches of this unit, since unit reliability declines with depth, and deeper strata may be naturally contaminated by salts, hydrogen sulfide or methane.

The unconsolidated sediments units receive recharge from precipitation, and from surface stream flow during dry periods.

By some estimates this recharge may be as much as 25 percent of all available precipitation (about 46 inches per year). The unconsolidated sediments may act as recharge galleries for the Utica Shale, but the percentage of total recharge entering the bedrock hydrogeologic unit by this means is unknown. The amount of recharge to bedrock, however, is expected to be relatively small due to the expected large differences in hydraulic conductivities between the unconsolidated and bedrock units. The percentage of total recharge which discharges in sustaining spring and stream baseflows is also unknown.

3.5 HISTORY OF WASTE DISPOSAL

Figure 3 is an index map of Griffiss, upon which the locations of all of the waste disposal sites of concern to this study are plotted. Summaries of the history and practice of use of these sites were provided in the Phase I Report, and are reproduced here in the following paragraphs.

3.5.1 Landfill No. 1

Landfill No. 1 is situated in the northern portion of Griffiss and encompasses approximately 22 acres (see Figure 3). Prior to its use as a landfill, a gravel quarry was located on the site. The landfill began operations in 1960 and closed in 1973. In 1973, debris from a fire in the base comissary was buried near the intersection of the entrance road and Six Mile Creek.

All landfilling was accomplished by trench and cover methods, with the exception of some hardfill and steam plant boiler ash which was dumped and spread on the eastern edge of the trenches. Early cells were constructed in an east-west orientation and were from 40 to 50 feet wide by 300 to 500 feet long. Depths of waste were from 15 to 18 feet. During construction of the 2nd and 3rd trenches from the north, ground water was encountered and pumped to Six Mile Creek. A later trench was started in a north-south orientation through the east end of the earlier trenches, but was abandoned. Waste ash from the steam plant was used during one period as cover material for the solid wastes.

Most of Landfill No. 1 appears to be graded to drain to a low area to the east, and then on to Six Mile Creek. The extreme southwestern portion of the site drains directly to Six Mile Creek about three miles upstream from its confluence with the New York State Barge Canal. The site is at an elevation of about 540 ft. msl, and was constructed in the relatively coarse-grained Pleistocene glacial deposits.

Leachate seeps are evident along a portion of the southwestern toe of the landfill along Six Mile Creek. These seeps appear to originate from within Landfill No. 1. The leachate flow has become channelized near its interception by Six Mile Creek, and was visually estimated to flow at a rate of about 5 gpm.

Some solid waste from Landfill No. 1 is visible in the drainage ditches of the road leading to the firing range. These wastes have been uncovered by road construction over the last solid waste cell, and by subsequent soil erosion due to runoff. There are also mounds of soil and waste on the eastern edge of the landfill, from which unlabeled, empty metal 55-gallon drums are exposed. Several small open burning areas with empty drums and some partially-filled cans of an unknown crystalline chemical were observed on the southeastern edge of the site. The remains of decomposed cardboard drums are also visible. Other areas of the landfill are well vegetated in grass and much of the area has been reforested with red pine, white spruce, scotch pine, American cedar, larch, black walnut and evergreen vegetation. Landfill cover is composed of the native coarse grained glacial deposits.

3.5.2 Landfill No. 2

Landfill No. 2 is situated in the eastern-most region of the base, as shown in Figure 3. This 60-acre site is contiguous with landfill No. 3, and these two sites are treated as a single unit.

The lower or southwestern portion was operated as a location for hardfill disposal by an area method, and for other solid waste disposal by the trench and cover method. The upper or northeastern portion of the landfill was operated in a trench and cover mode and was the last active disposal site on base. While major filling operations ceased in October, 1980, one trench located in the southeastern-most extremity of the northern portion of the site has remained open to receive on board domestic wastes from overseas aircraft. The wastes have been boiled prior to emplacement.

Part of the upper site is graded to drain to the northeast toward a tributary of Slate Creek, which, in turn, drains to Six Mile Creek. The remainder of the upper site and the entire lower site drain to Six Mile Creek about one mile from its confluence with the New York State Barge Canal.

At the time of the site visit, closure of the landfill was not yet complete. Some surface grading had been done. No vegetative

stabilization of the landfill has occurred. A permanent wire mesh fence about 12 feet high by 150 feet long has been installed in the northeast area of the landfill as a stop for wind blown refuse . It is undestood that during operation of this landfill, portable fences about six feet high surrounded the disposal areas. Security at the landfill consists of a trench and berm across the entrance road and a three foot high perimeter security fence that borders the site on the southeast and north sides.

Landfill No. 3 is located within the limits of Landfill No. 2. It operated as a disposal area for asbestos wastes, beginning operations in 1980 and receiving these wastes on an intermittent basis. Asbestos waste has been generated primarily from demolition and repair of asbestos insulated piping. The asbestos has been wetted, double bagged and hauled to the disposal area where pits were dug to about 8 feet deep. Security for the site is the same as that for Landfill No. 2. A warning sign in the vicinity of the disposal area physically identifies the location. All asbestos wastes were said to be buried within 25 feet of the sign. It has been estimated that one ton of asbestos is located in Landfill No. 3. There are no visible surface features other than the sign to indicate the location or extent of the asbestos burial area. This method of asbestos disposal has been approved by the State of New York and by the USEPA.

3.5.3 Landfill No. 5

Landfill No. 5 is situated on about four acres near the intersection of Patrick Square Road and Perimeter Road (see Figure 3). Patrick Square Road and an unnamed dirt access road border the site to the north and east, respectively. The landfill operated for about a year following the abandonment of Landfill No. 6 in 1959. The southern part of the site was constructed in a wetland area adjacent to Three Mile Creek, and the site drains south to Three Mile Creek near its confluence with the New York State Barge Canal.

The landfill was constructed using an area type method to a total depth of about six feet. Wastes hauled to the site were burned at the landfill and then covered. A number of persons interviewed recalled underground fires that were difficult to extinguish. The site is now well vegetated in grass and small hardwoods, and to the southwest, the area is heavily wooded in medium to large hardwoods.

3.5.4 Landfill No. 6

Landfill No. 6 is located on about eight acres between Perimeter Road and Three Mile Creek as shown on Figure 3. The landfill operated from 1955 until 1959, receiving hardfill (construction and demolition debris, wooden pallets, etc.) as well as municipal solid wastes (MSW) and other base wastes. Hardfill was placed in a designated hardfill area on the western extremity of the site. The remaining area is physically divided by a dirt and gravel access road into a north area and a south area. The north area was constructed on a hillside with a ten percent slope, and wastes were dumped at the top of the hill and burned on the hillside. The thickness of waste and burned residue on the hillside was estimated by one perseon to be five to ten feet. This area is now well vegetated with grass and small conifers and there is no visible evidence of leachate.

The south area lies on the opposite side of the dirt access road from the north area. Disposal in this area was accomplished by spreading wastes to an average depth of four feet and then covering. This area is flat and is now stabilized in grass, although the surface of the fill area has some small local depressions. The edge of the fill on the south side slopes down to the wetland area adjacent to Three Mile Creek.

3.5.5 Landfill No. 7

Landfill No. 7 is located on about 4.5 acres at the public runway observation point (Figure 3). This landfill was the first operated at Griffiss, opening in 1950 and closing in 1954.
The landfill was operated using a trenching method with approximately four 20-foot deep trenches cut 50 to 60 feet wide and about 400 feet long, running parallel to the main runway. Waste collection vehicles entered the trenches al- ternately from one end and then the other from one day to the next. On any given day, one end of the trench would be in a waste-burning phase while the other would be in a receiving phase. Persons interviewed recalled liquid wastes being occasionally disposed of in the trenches. Liquids were buried in small pits dug in the bottom of the trenches.

When the landfill was closed, the area was vegetated with a thick grass cover. The surface now has numerous depressions and burrowing animal holes. Around the entrances to the burrows is evidence of charred wood and ashes apparently displaced from the waste material below. The site drains to a low area to the southwest, which in turn drains to Six Mile Creek. There was no

evidence of leachate along the toe of the fill, or of surface ponding on the landfill cover. No fence, gates, signs or markers exist to indicate the location or extent of the landfill.

3.5.6 Dry Wells

The base has used a number of direct-disposal dry wells in the past for the disposal of wet chemical wastes from the industrial shop area. In some cases these wells are stone and gravel filled pits roughly three to four feet on a side and ten feet deep. Liquid wastes, some of which were hazardous, have been placed in these dry wells and allowed to infiltrate directly to the groundwater system. In some other cases these dry wells are completely poured concrete sumps which have been used to store liquid wastes prior to their recovery for treatment.

Of particular importance to this study is the dry well located adjacent to Building 301, the Entomology Laboratory. Small quantities of pesticides have been disposed of in this dry well and allowed to infiltrate into the groundwater. Because of the porous sand and gravel subsoil percolation of liquid wastes can be expected to be rapid. The dry well was not accessible for inspection, although its position is well documented. This Drywell was evaluated as a surrogate for other higher priority drywells whose positions are either unknown or are inaccessible for evaluation.

3.5.7 Potential PCB Contamination Site

Griffiss is conducting an on-going program to identify transformers which are filled with PCB oil. When they are removed from service, they are stored in a small area adjacent to building 112, the high power laboratory (see Figure 3). Spillage is known to have occurred in this area, and the Air Force has conducted a sampling and analysis program to determine the extent of this spillage.

SECTION 4

GEOTECHNICAL INVESTIGATION

4.1 GENERAL

U.S. Air Force field investigations characteristically are conducted in two stages, a Problem Confirmation Stage and a Problem Quantification Stage. The Confirmation Stage is intended as a generalized fact-finding mission, in order to confirm whether or not a problem does exist, and in order to collect sufficient data to design a field investigation to complete the definition of that problem. The Quantification Stage of the investigation is intended to complete the definition of the magnitude and extent of the problem, and to provide data input to Concept Engineering evaluations of appropriate remediation options. The evaluation of Landfill No. 1 proceeded in just this fashion. The Records Search Report had indicated a discolored leachate seep emanating from Landfill No. 1, and had indicated some impact upon the receiving waters of Six Mile Creek. Because of the leachate seep and the high priority ranking in the Phase I report, a full scale Confirmation and Quantification Study of Landfill No. 1 was requested. At all other sites only a suspicion of environmental problems existed, based upon the Records Search Report, and, therefore, only a Confirmation Stage investigation was requested at those sites to determine whether or not environmental problems existed. If the results of the Confirmation Stage had indicated the existence of a problem this would have triggered a further evaluation of the site, and probably would have caused initiation of a Quantification Stage investigation at those additional problem sites.

4.2 METHODS

4.2.1 General

Field investigations involve a wide variety of technical activities, including:

- Remote sensing techniques such as aerial photograph analysis
- Geophysical techniques including earth resistivity and ground penetrating radar

- Surface and subsurface sampling of sediments and soils
- Monitor well construction
- Ground water and surface water sampling and analysis
- Aquifer characteristics testing

Brief descriptions of these general types of activities, as they were applied to the geotechnical investigation at Griffiss, are contained in the following paragraphs.

4.2.2 Remote Sensing Techniques

Remote sensing techniques are basically methods of detecting the existence of a phenomenon through the detection of indirect evidence of its existence. For example, a spill of a toxic chemical may have occurred at a site in the past--direct, visual evidence of the spill may no longer be present, but evidence of vegetation stressed or killed by the chemical may still be detectable. Such remote sensing techniques are normally applied at three different levels of sophistication.

- At the field level, where no auxilliary equipment or devices are used
- At an intermediate, laboratory level, where routinely available aids are used--aerial black and white and thermal infrared imagery
- At an advanced laboratory level, where sophisticated computer enhanced imagery is typically used

At Griffiss each disposal site was inspected visually for evidence of leachate seeps, surface water flow, stressed or dead vegetation, surface soil discolorations, topography and other surficial phenomena such as exposed drums, burn pits and chemical spill evidence.

At the second level of sophistication, WESTON was provided panchromatic and thermal infrared photos by the Intelligence Division, 416 Bomb Wing, for aerial photo analysis. They provided photo enlargements that covered all of the sites subject to this investigation. These photos were examined for evidence of vegetative stresses, overland flow of contaminated wastes and for other key indicators.

4.2.3 Geophysical Techniques

4.2.3.1 Earth Resistivity

Electrical resistivity investigations are based on the principle of applying electric current to the earth through two electrodes and measuring the potential difference between two or more other electrodes within the circuit. The distance between the electrodes and the measured potential difference are the input data used to make interpretations of subsurface conditions.

There is considerable overlap in the resistivity of various materials due to moisture content and expecially to the dissolved solids content of the water. The dissolved solids content of ground water can change due to drought, excessive rainfall and changes in water level.

In New York, West Texas, and on Long Island, recent investigations have been made using resistivity equipment to detect ground water pollution from septic tanks and oil field brine disposal pits. The contaminated water had higher concentrations of dissolved solids than non-contaminated ground water. In some cases low apparent resistivity readings were interpreted as contaminated ground water. In other cases the conditions of resistivity of unsaturated material overlying the aquifer, thickness and depth to the saturated aquifer, and resistivity of the material underlying the aquifer prevented identification of contaminated ground water.

At Griffiss earth resistivity surveys were at the sites under investigation. The purpose of these surveys was to assist in ascertaining the presence or absence of a ground-water contaminant plume at each site based on resistivity anomalies produced by dissolved contaminants in the groundwater. This data would be used as one of the site selection criteria for new monitor well locations.

4.2.3.2 Ground Penetrating Radar (GPR)

GPR is an impulse radar system that provides a continuous profile of subsurface conditions by radiating electromagnetic pulses into the earth (or water) and displaying the reflections from surface and subsurface interfaces on a strip-chart recorder.

GPR subsurface surveys are used to map soil and geological characteristics and to locate buried objects such as pipes, barrels, cables and conduits. The product of a GPR survey is a series of subsurface profiles which display the various soil and geological interfaces encountered. Buried objects will be displayed as a distinct set of interfaces and, in the case of round objects such as pipes and barrels, will display a characteristic signature. A more detailed explanation of the GPR theoretical and operational principles is given in Appendix B.

The penetration depth of the GPR system is dependent upon the effective conductivity of the material being probed. In highly conductive materials, the GPR signal is rapidly attenuated, severely limiting the penetration depths. For example, penetration through wet clay is only about five feet, and penetration in sea water deteriorates to less than a foot. This is in contrast to penetation depths through low conductivity materials, such as dry sand or rock, which can reach depths of perhaps as much as 100 feet.

Although a GPR subsurface survey was not required by this Task Order, WESTON decided to use the GPR on an experimental basis at Landfill No. 1. The two primary objectives of the GPR tests were: determine the usefulness of the data in the analysis and understanding of soil and bedrock conditions; determine whether or not the GPR could delineate the landfill boundaries. The results of these tests are presented in section 5.3.7.

4.2.4 Sediment Sampling

Subsurface sampling of soils and sediments is normally done during pilot hole drilling for monitor well construction. When using auger-type drilling equipment, as at Griffiss, the samples are taken using a conventional split-spoon sampler in accordance with the procedures of the Standard Penetration Test (ASTM D-1586). This procedure involves advancing the split spoon sampler through undisturbed sediments using a standard 140-pound hammer falling a uniform 30 inches against the top of the sampler. Blow counts are recorded for each 0.5-foot advance of the sampler. This procedure was used at Griffiss, with samples being obtained at a rate of two feet of sample per five feet of drilling.

The purposes of subsurface sampling were several:

- Obtain intact sediment samples from specific subsurface horizons to enable accurate stratigraphic descriptions.

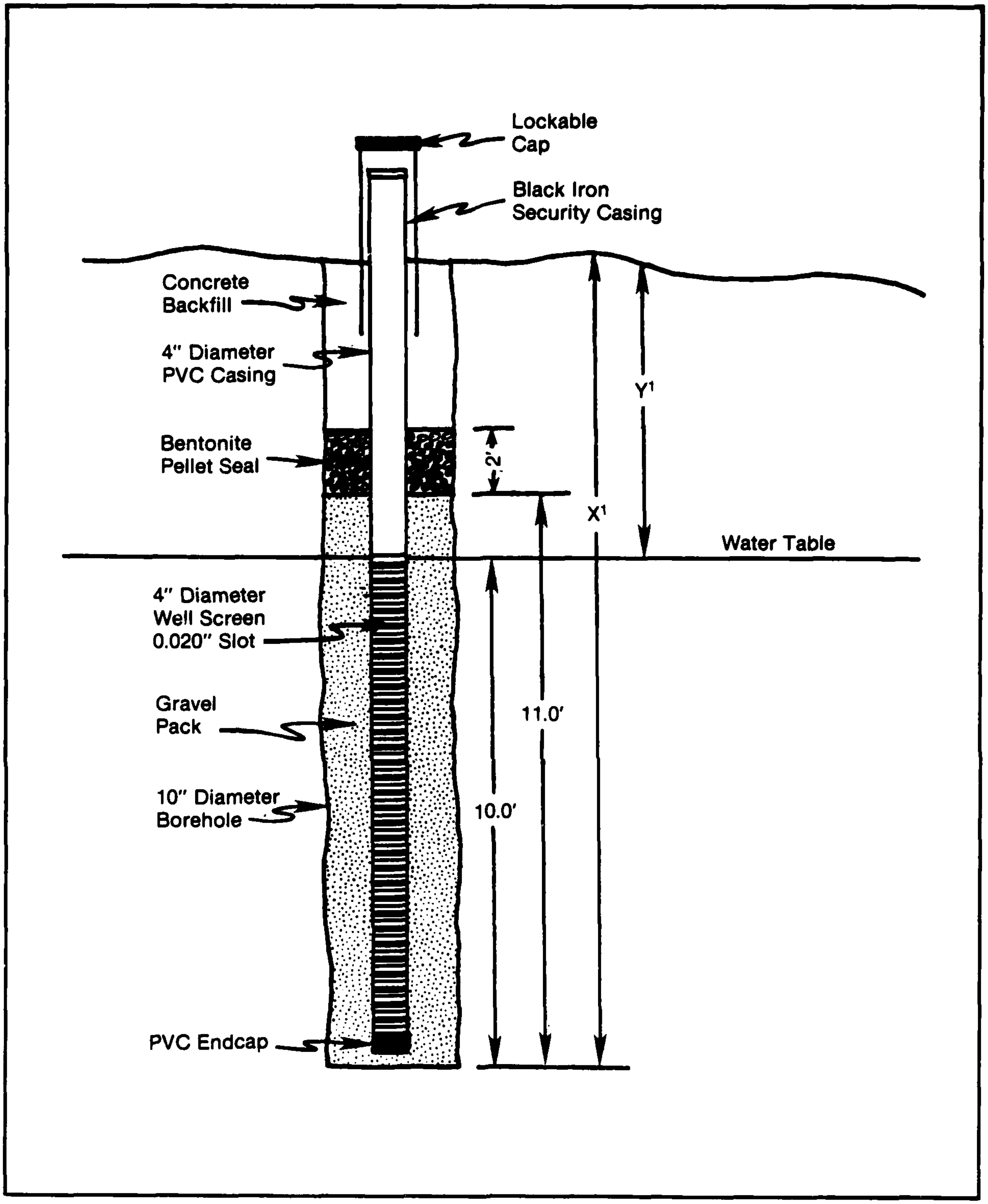

FIGURE 4 GENERALIZED SCHEMATIC OF MONITOR WELL CONSTRUCTION, GRIFFISS AIR FORCE BASE, ROME, NY

Well construction was completed with the installation of a 6-inch diameter black iron security casing into the backfilled grout collar. Each security casing was equipped with a cap and locking HASP.

Upon completion of well construction, and after the grout backfill had hardened, each well was pumped to remove fines and set the gravel pack against the screen. By accomplishing such development pumping, WESTON is able to ensure that pumpage runs clear and sediment free, and that the well will produce representative samples for chemical analysis.

4.2.6 Ground Water and Surface Water Sampling and Analysis

4.2.6.1 Ground-Water Sampling

Standard sampling practice at WESTON calls for the removal of a minimum of three to an optimum of five volumes of water standing in the well and gravel pack prior to sampling, in order to ensure that a representative sample of ground water is obtained. At Griffiss the 4-inch diameter wells were installed inside approximately 10-inch diameter borings. For such a configuration of well, water standing in the well at gravel pack level would represent about 4.1 gallons per foot of standing water, and water standing in the riser pipe above the gravel pack would represent about 0.7 gallons per foot of standing water.

The WESTON sampling personnel first measured the depth to water in a well, then calculated the volume of standing water in the well by comparing that measured depth with the construction records for that well. A submersible pump, which yields about 10 gallons per minute, was installed and allowed to pump to waste the optimum five volumes of standing water. If the well will not sustain such pumping, either the pump is cycled on and off, or a bailer is used until the required volume of water is removed. At that point the collection of representative water samples proceded.

All sample bottles and vials were prepared and preserved in accordance with standard Environmental Protection Agency (USEPA) protocols for the particular analytes of concern. With the exception of volatile organics (VOA) samples, all water samples were taken using a submersible pump with samples being taken at the pump discharge hose. Water samples taken for analysis of trace metals were field filtered through 0.45 micron Millipore ™ filters under vacuum. Samples for VOA analyses were taken using a stainless steel bailer which had been acetone washed

then triple rinsed with double-distilled water. All samples were shipped to the laboratory on ice pending analysis.

4.2.6.2 Surface Water Sampling

Surface water samples were taken from streams and creeks in the "tube" of maximum velocity and flow volume. This "tube" is characteristically located in the section of the creek having the largest unit cross-sectional area, and is located approximately at a height of 1/3 of the total water depth off the bottom. The person taking the sample stood downstream of the sampling point and sampled in an upstream direction. The sample bottle was submerged while capped, uncapped in the sampling position, then recapped for removal, field filtration and transferral to sample vials. All samples were shipped to the laboratory on ice pending analysis.

4.2.6.3 Laboratory Analysis

The WESTON laboratory used only USEPA approved analytical protocols for samples from Griffiss. All volatile organic scans were accomplished using WESTON's Finnegan Model OWA linked Gas Chromatograph and Mass Spectrometer (GC/MS) and followed USEPA Standard Procedure No. 624. Acid Extractable, Pesticide and Base/Neutral Fractions were also analyzed by GC/MS and followed USEPA Standard Procedure No. 625. Organo-Chlorine Pesticides were analyzed by gas chromatography (GC) with an Electron Capture detector, in accordance with USEPA Standard Procedure No. 608. Phenols were analyzed using High Performance Liquid Chromatography (HPLC) by USEPA Standard Method No. 604. Trace metals are run by Inductively Coupled Argon Plasma Spectroscopy (ICAP), except for arsenic and selenium (using flame vapor Atomic Absorption Spectrophotometry) and mercury (using cold vapor Atomic Absorption Spectrophotometry).

4.2.7 Aquifer Characteristics Testing

The purpose of these tests is to determine aquifer transmissivities, or the ability of the formation to transmit water through its pore spaces. The basic method of performing these types of tests is to stress the aquifer by removing water from a well and then measuring the aquifer's response to that stress. Conventional pumping tests are the most widely accepted method of making this measurement.

In the most common pump test, a pump is installed and allowed to pump at a constant rate for a predetermined period of time, while water levels were measured at the pumping well and at all other relatively close monitoring wells. Only one such test could be conducted at Landfill No. 1 because none of the other wells would produce sufficient quantities of water to sustain a pump test.

The second method of stressing the aquifer employs the slug test. In this type of test a fixed volume of water is removed from the well "instantaneously," and recovery of the slugged well is monitored. This method provides a measurement of hydraulic conductivity and transmissivity in wells whose low yields make pump tests impractical. The results computed from the test apply only to the immediate area of the slugged well, and may not be applicable to other wells screened in the same hydrogeologic unit.

SECTION 5

GEOTECHNICAL AND CONCEPT ENGINEERING INVESTIGATION OF LANDFILL No. 1

5.1 GENERAL

The purpose of this investigation into Landfill No. 1 was to ascertain by geotechnical methods the field environmental conditions within which the landfill exists. The data collected during the geotechnical field investigation were to be sufficiently detailed to support a preliminary concept engineering assessment of alternative remedial actions. Several specific questions were to be answered during this investigation:

- Determine the extent and magnitude of environmental contamination which has resulted from previous waste disposal practices at Landfill No. 1.
- Determine whether or not contamination from Landfill No. 1 is presently migrating off-site and assess the potential for such occurrences in the future.
- Identify alternatives for mitigating any adverse environmental effects of existing contamination problems.
- Suggest potential ways of restoring the environment to as near a normal level as is practical.
- Suggest a future environmental monitoring program to document environmental conditions at Landfill No. 1.

Based on the findings of Phase I Records Search, Landfill No. 1 was identified as a first priority site and therefore a complete two-stage evaluation of Landfill No. 1 was performed.

5.2 CONFIRMATION STAGE INVESTIGATION

5.2.1 Site Reconnaissance

The first activity undertaken in the Confirmation Stage investigation was an in-depth inspection of Landfill No. 1. Landfill

No. 1 is located in the extreme northern portion of the base property, just north of the Small Arms Firing Range, as shown in Figure 5. Figure 6 is an expanded view of the configuration of Landfill No. 1. The disposal site occupies approximately 22 acres of an area of above average elevation northeast of Six Mile Creek. The site surface lies at elevations of between 530 and 540 feet above mean sea level (MSL) and drops abruptly at the toe near Six Mile Creek to an elevation of approximately 500 feet above MSL. The area to the southwest of Six Mile Creek is level marsh land, with some evidence of its use for dumping of hardfill wastes.

The landfill area was previously used as a sand and gravel quarry. The landfill was a "trench and cover" type of operation open from 1960 to 1973 and holds general refuse and boiler ash. The exact boundaries of the landfill could not be determined from field inspection data. The site was not lined or capped to control water infiltation. The landfill was subsequently covered with native sand and gravel and some areas were replanted with softwoods. The site surface drains generally to the southeast toward a small tributary of Six Mile Creek. However, the surface is uneven, probably caused by differential settlement, and ponding occurs after rainstorms.

Some debris is still visible on the surface of the site, particularly at the eastern end of the site where there appears to have been some burning of small cardboard and metal containers containing paint, fire fighting chemicals and other unknown substances.

At the base of the slope adjacent to Six Mile Creek, southwest of the landfill, there is a perennial seep. It emerges from several points along a short (approximately 150 feet) front of the slope, where it feeds a wet area adjacent to the creek. Eventually it enters the creek principally through two rivulets having a combined flow of about five gallons per minute. The discharge point of the seep into the creek was slightly foamy for a few yards downstream. The seep has a rust red tint and has stained the ground it has flowed over; small deposits of white crystalline material were also observed. The seep appears to be fed by water percolating through the landfill. There is a concrete structure near the seep outlet which apparently was a springhouse. The date "1934" is etched on the wall. It seems likely that the seep is, at least in part, a spring that existed before the landfill, and that it receives at least some of its recharge

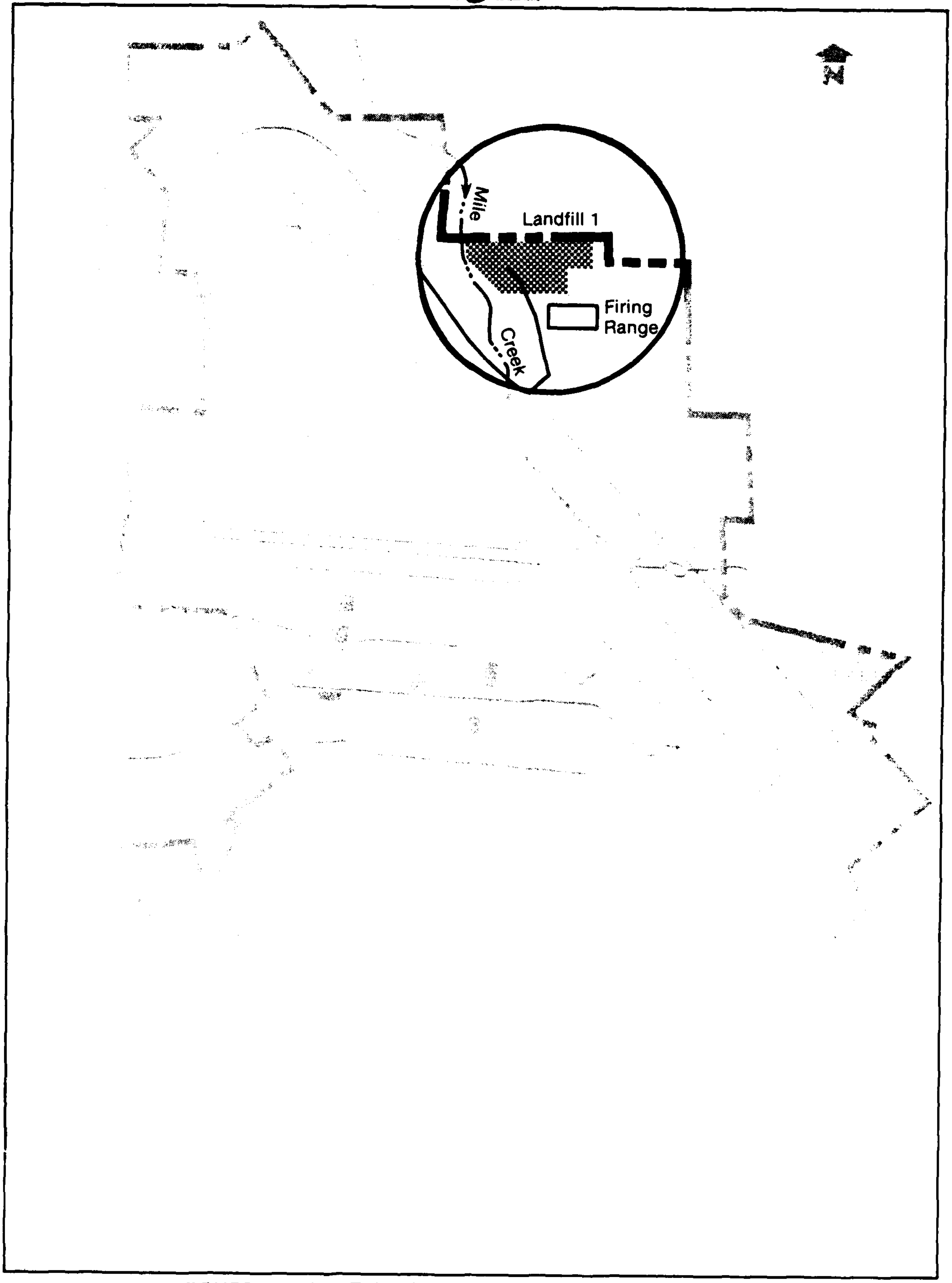

FIGURE 5 LOCATION OF LANDFILL NO. 1, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

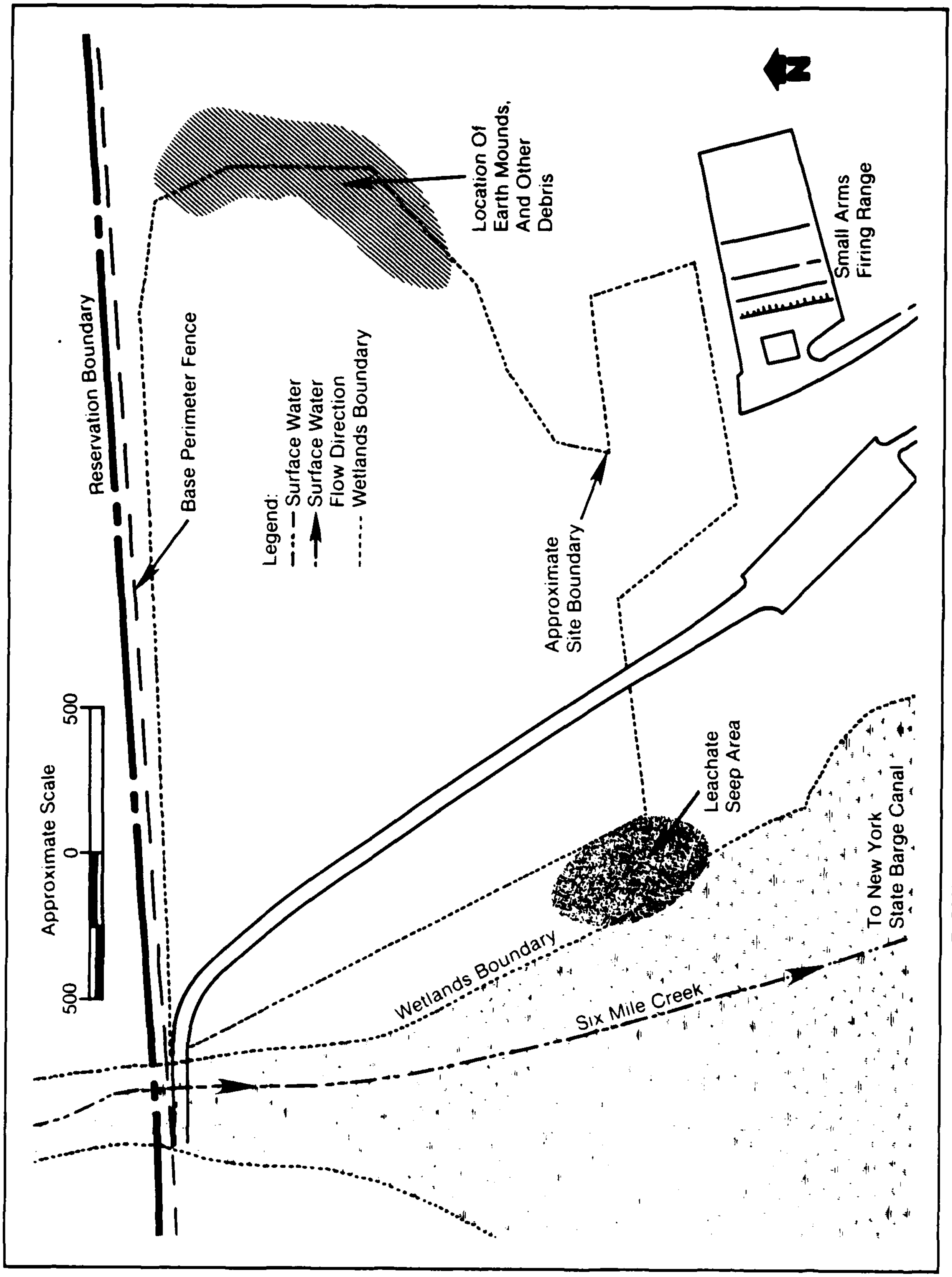

FIGURE 6 EXPANDED PLAN VIEW OF LANDFILL NO. 1, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

from the area now occupied by the landfill. Inspection of vegetation around the entire site revealed almost no stressed vegetation. Only in the immediate vicinity of the leachate seep was vegetative stress obvious, and at least some of that stress could be attributable to continuous inundation of plant root systems. Most of the vegetation growing within the seep area is, however, vigorous and luxuriant.

5.2.2 Remote Sensing Investigation

Aerial photos were obtained from the Intelligence Division, 416 Bomb Wing. These photos clearly depicted Landfill No. 1 during various years in the past, in both black and white and in thermal infrared prints. Inspection of these photos assisted in delineating a better set of boundaries for the landfill than was possible from visual reconnaissance. Meticulous examination of the prints, however, detected no evidence of stressed vegetation or thermal irregularities which could have provided the locations of any subsurface leachate plume other than the one at the seep.

5.2.3 Earth Resistivity Survey

WESTON conducted earth resistivity surveys around Landfill No. 1 using a Soiltest Model R-40 Resistivity Meter. The purpose of these surveys was to identify lateral variations in earth resistivity that may reflect subsurface leachate plumes and help to locate monitor wells required to define the problem. Approximately 12 earth resistivity stations were located and measurements made at each at a constant spacing of 10 feet. Most of the profiles concentrated along the toe of the landfill, but other transects were also run for contrast with the location of the known plume. Even adjacent to the plume, earth resistivity readings displayed only small variations. WESTON concluded that too many significant variables, such as material surveyed, depth to water, depth to bedrock and conductance of ground water, were varying too widely to establish control over the survey. Further efforts in earth resistivity were abandoned at Landfill No. 1.

5.2.4 Installation of Monitor Wells

Site topography and surface drainage patterns indicated that the general water table flow direction should be across the site from roughly northwest to southeast, toward a tributary of Six Mile Creek. Field reconnaissance data, coupled with field checked data from the analysis of aerial photos, allowed selection of Site W1 as being an upgradient, background location outside the boundary of the landfill. WESTON then used the "three

downgradient" principle from the Resource Conservation and Recovery Act of 1976 (RCRA), and selected sites W5, W6 and W7. These sites are along the southwest bank of Six Mile Creek, directly across the creek and only a few tens of yards from the leachate seep area. WESTON would have preferred to install the downgradient wells on the landfill site of Six Mile Creek. However, the very steep toe of the landfill, the heavily wooded vegetation and the position of the creek restricted drill rig access. The four well sites selected are shown in Figure 7.

All four wells were drilled during November and December 1981, using auger drill equipment, and were drilled and developed in the manner described in Section 4.2.5 of this report. Bedrock was encountered in the three downgradient wells at unexpectedly shallow depths. Well construction details and boring logs are contained in Appendix C, and well configuration data are summarized in Table 2. A preliminary round of water level data confirmed that the topographic analysis and the assumption of the water table mimicking topography had been correct. The direction of ground-water flow was toward Six Mile Creek.

5.2.5 Ground-Water Sampling and Analysis

On 11 January 1982, approximately two weeks after completion of development pumping, an initial round of water quality samples was taken from the four Landfill No. 1 monitor wells. Sampling was accomplished as described in Section 4.2.6.1 of this report. Samples were taken for complete analyses of the USEPA Priority Pollutant List, a listing of the compounds of which is in Appendix D of this report. Samples were transported to the WESTON laboratory on ice, and were extracted and analyzed in accordance with Standard USEPA protocols as noted in Section 4.2.6.3 of this report. Table 3 contains a summary of the data obtained by those analyses--compounds listed in Appendix D but not in Table 3 were below quantifiable detection limits.

Well W5 is directly across Six Mile Creek from the seep, and contained quantifiable benzene (11 ppb) and ethylbenzene (92 ppb). Well W1, the background well, contained zinc in what appeared to be an anomalously high concentation. Well W6 contained elevated soluble chromium and W7 contained elevated zinc. No other compounds were detected at quantifiable concentrations. Several other compounds were detected in trace amounts, most notably some of the phthalates. WESTON's Quality Assurance (QA) Officer was of the opinion that a possible QA problem existed, due to the relatively low concentrations of those contaminants detected and due to the relatively high degree of scatter in the

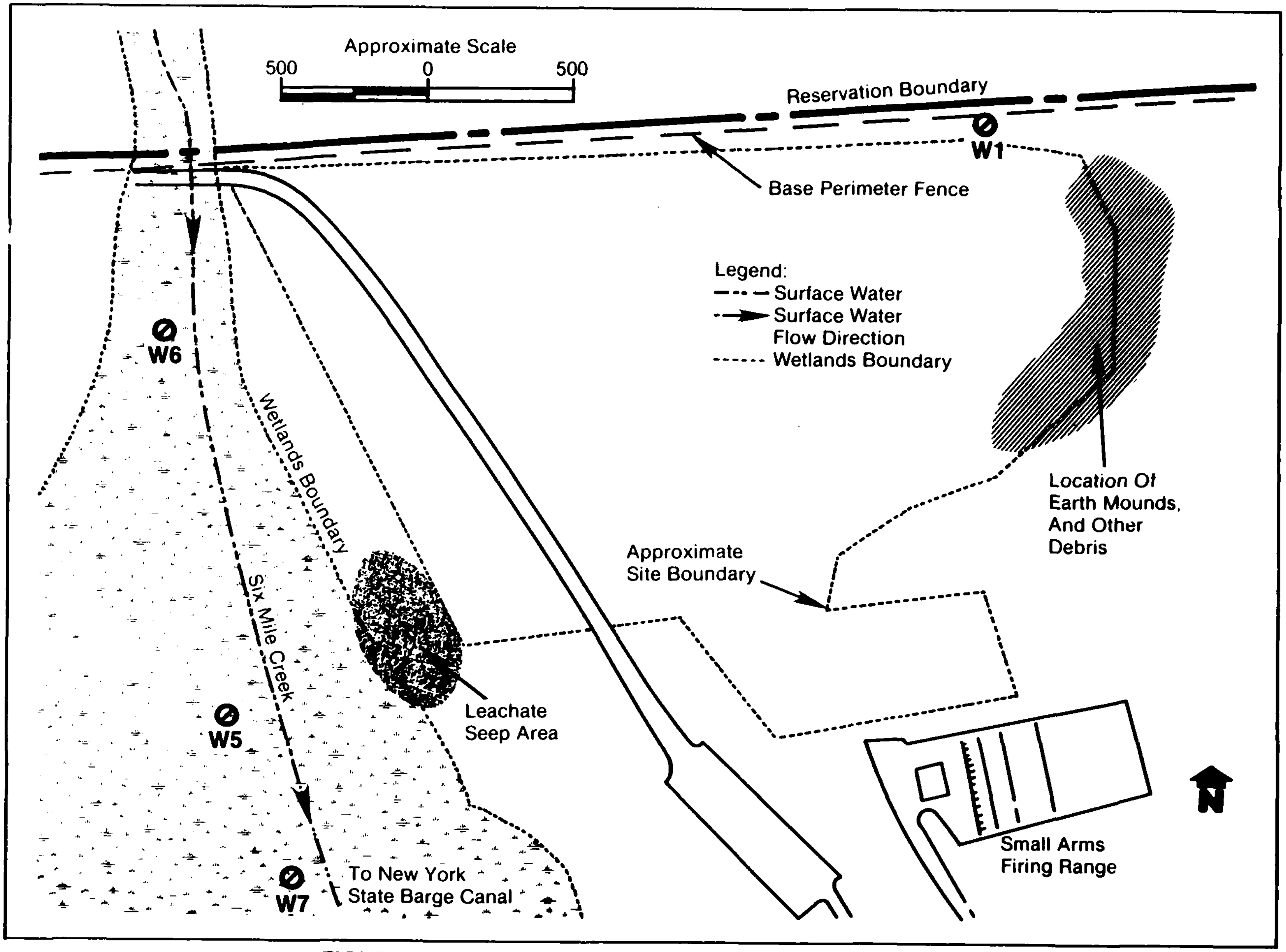

FIGURE 7 LOCATIONS OF FOUR CONFIRMATION STAGE MONITOR WELLS, LANDFILL NO. 1, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

Table 2

Monitor Well Construction Data for
Four Confirmation Stage Monitor Wells, Landfill No. 1

Well	Location	Well Depth (in feet)	Screen Depth Interval (in feet)	*Elevation of Top of Casting (TOC)	Depth to Water (in feet from TOC)	Ground Water Elevation (4-18-82)
W1	NE Corner-Base Boundary	14.5	4.5 - 14.5	540.8	9.0	531.8
W5	SW Side - Six Mile Creek Wetlands	20.0	10.0 - 20.0	497.7	5.4	492.3
W6	SW Side - Six Mile Creek Wetlands	15.0	5.0 - 15.0	499.6	3.2	496.4
W7	SW Side - Six Mile Creek Wetlands	17.0	7.0 - 17.0	495.9	3.3	492.6

*Relative elevations of wells were determined by ground survey using W5 as arbitary datum. Elevation of W5 in reference to mean sea level is approximate, based on existing contours on base plan.

Table 3

Analyses of Ground Water Samples, Landfill No. 1, 11 January 1982

Well	Location	Cr (Sol)[1] (mg/l)	Cu (Sol) (mg/l)	Zn (Sol) (mg/l)	Phenols (mg/l)	VOA[2] (ug/l)
W1	Upgradient	<0.05	0.04	1.05	<0.005	<10
W5	Downgradient	0.06	0.05	0.14	<0.005	11 (Benzene) 92 (Ethyl benzene)
W6	Downgradient	1.24	0.05	0.11	<0.005	<10
W7	Downgradient	0.20	0.06	2.31	<0.005	<10
Detection Limits		0.05	0.02	0.02	0.005	10 (each parameter)

Notes: [1]Sol indicates dissolved metals.
[2]VOA indicates USEPA Priority Pollutant List Volatile Organic Compounds (see Appendix D).

QA duplicates analyzed. Prudence indicated that additional analyses were needed, and the QA Officer requested an additional round of samples for a repeat analysis.

On 16 February a second round of water samples was taken from the landfill No. 1 wells, in exactly the same manner as previously described, including a higher percentage of additional QA samples.

Table 4 is a summary of the results obtained from this second round of sampling. For ease of comparison, Table 3 data are also contained in Table 4. The presence of benzene and ethyl benezene in Well W5 was confirmed. However, the elevated metals levels from the first sampling round were not confirmed. Slightly elevated phenol levels were detected, with Well W5 showing the highest level at 58 ppb. No other compounds listed in Appendix D were detected.

5.2.6 Conclusions From The Confirmation Stage

The following conclusions were drawn from the results of the Confirmation Stage efforts. These conclusions also assisted in making work scope adjustments to the Quantification Stage effort.

- Bedrock downgradient from Landfill No. 1 was encountered at 8-12 feet rather than the 70-100 feet anticipated from the Records Search Report.
- The line described by Wells W5, W6 and W7 probably represented the approximate position of farthest downgradient migration position of detectable contaminants from the Landfill No. 1 other than downstream on Six Mile Creek.
- Preliminary ground-water and chemistry data indicated that the known leachate seep was the surface expression of the only "plume" leaving the landfill.
- The extent of the "plume" was yet to be ascertained.
- The impact of the leachate seep was yet to be quantified.
- Field reconnaissance indicated a possible lobe of the leachate seep farther to the southeast and east than was indicated in the Records Search Report.

Table 4

Summary of All Confirmation Stage Analyses
of Ground Water Samples, Landfill No. 1

Well	Location	Date	Cr (Sol)[1] mg/l	Cu (Sol) mg/l	Zn (Sol) mg/l	Phenols mg/l	VOA[2] ug/l
W1	Upgradient	2/16	< 0.05	< 0.02	< 0.02	0.005	< 10
		1/11	< 0.05	0.04	1.05	< 0.005	< 10
W5	Downgradient	2/16	< 0.05	< 0.02	< 0.02	0.058	58 (Benzene)
							116 (Ethyl benzene)
		1/11	0.06	0.05	0.14	< 0.005	11 (Benzene)
							92 (Ethyl benzene)
W6	Downgradient	2/16	< 0.05	< 0.02	0.04	0.010	< 10
		1/11	1.24	0.05	0.11	< 0.005	< 10
W7	Downgradient	2/16	< 0.05	< 0.02	< 0.02	0.010	< 10
		1/11	0.20	0.06	2.31	< 0.005	< 10
Detection Limits			0.05	0.02	0.02	0.005	10 (each parameter)

Notes: [1]Sol indicates dissolved metals.
[2]VOA indicates USEPA Priority Pollutant List Volatile Organic Compounds (see Appendix D).

- The limited number of compounds detected in groundwater samples suggested that a very limited number of compounds should replace the Priority Pollutants List for any additional sampling analysis.

5.3 QUANTIFICATION STAGE INVESTIGATION

5.3.1 Additional Monitor Wells

A total of five additional monitor wells were installed around Landfill No. 1. The locations of these wells are shown on Figure 8. Each of these locations was selected, as follows:

- P1 was located adjacent to the base boundary to verify background chemistry data and to verify that groundwater flow gradients are not in an off-base direction.

- P2 was located to bracket the northwestern extremity of the leachate seep and plume area.

- P3 was located to bracket the southeastern extremity of the leachate seep and plume area.

- P4 was located to confirm or deny the field observation of an additional plume lobe.

- P5 was located to bracket the downgradient--most extreme of flow of the leachate plume.

Each of these five wells was installed using auger drilling equipment in the manner described in Section 4.2.5. Boring logs and well construction details are contained in Appendix C, and a summary of the construction details is contained in Table 5.

5.3.2 Subsurface Conditions

During the drilling of each well, subsurface conditions were described and split spoon samples were recovered at regular intervals. Subsurface conditions for each boring are presented in the stratigraphic logs in Appendix C.

The landfill area northeast of Six Mile Creek (Wells W1, P1, P2, P3 and P4) is directly underlain by glacial outwash sediments consisting of silty sands and sands, ranging from 9.5 to 34 feet in thickness. The sands, in turn, are underlain by glacial till

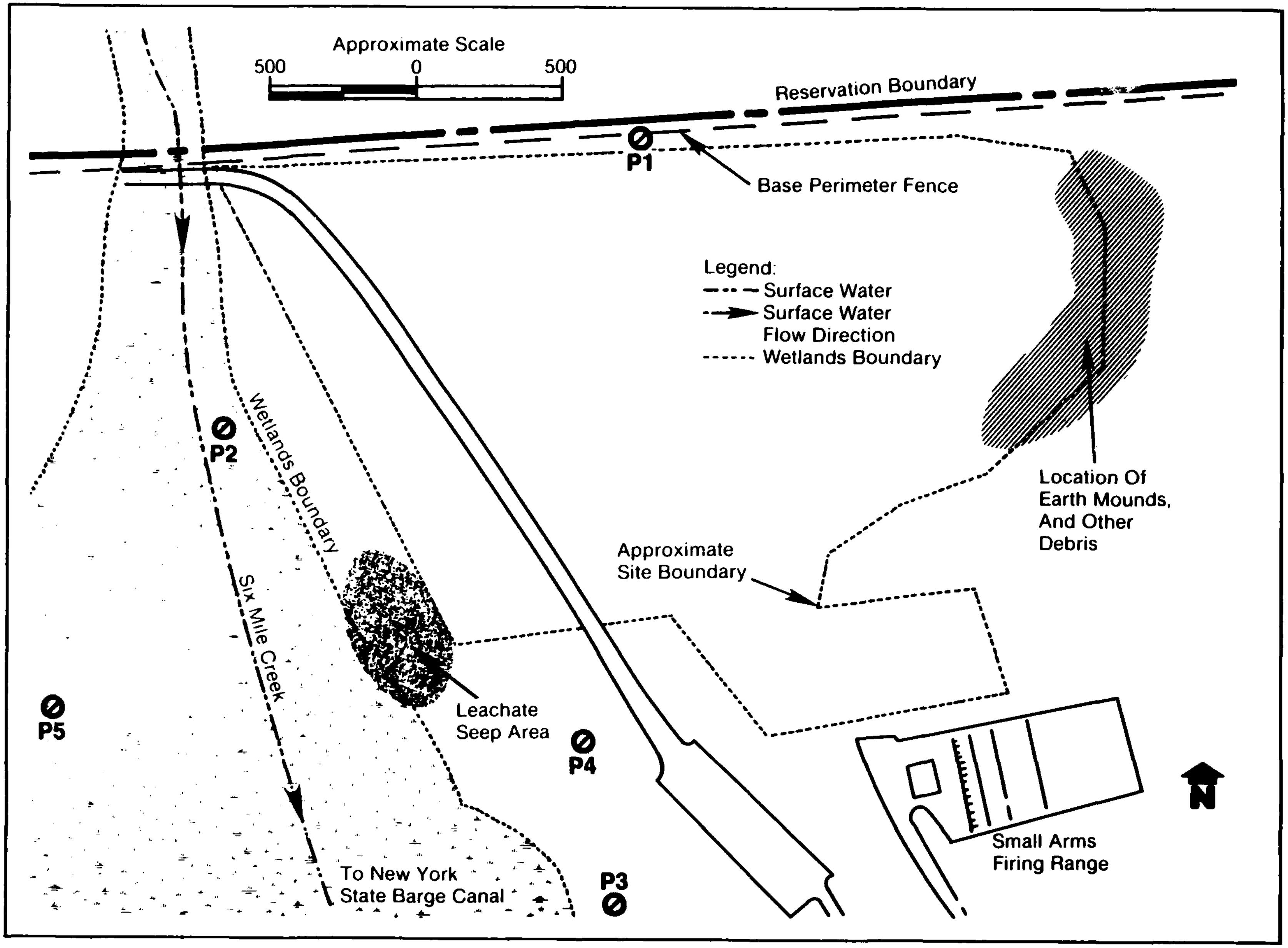

FIGURE 8 LOCATIONS OF FIVE QUANTIFICATION STAGE MONITOR WELLS, LANDFILL NO. 1, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

Table 5

Monitor Well Construction Data for
Four Quantification Stage Monitor Wells, Landfill No. 1

Well	Location	Well Depth (in feet)	Screen Depth Interval (in feet)	*Elevation of Top of Casting (TOC)	Depth to Water (in feet from TOC)	Ground Water Elevation (4-18-82)
P1	North Base Boundary Line	22.0	12.0 - 22.0	527.4	7.9	519.5
P2	SW Slope Toe	13.0	8.0 - 13.0	505.5	6.2	499.3
P3	SE Slope Toe	17.0	12.0 - 17.0	508.6	2.0	506.6
P4	South Slope	32.0	22.0 - 32.0	533.5	25.3	508.2
P5	SW Side-Six Mile Creek Wetlands	20.0	15.0 - 20.0	497.2	3.8	493.4

*Relative elevations of wells were determined by ground survey using W5 as arbitary datum. Elevation of W5 in reference to mean sea level is approximate, based on existing contours on base plan.

--a compact mixture of silty sand and gravel. The till ranged in thickness from one to three feet, and was in direct contact with the dark grey Utica Shale bedrock.

The wetland southwest of Six Mile Creek (Wells W5, W6, W7 and P5) is underlain by lacustrine sediments consisting of fine silts and sands, organic silts, and in P5, five feet of dense clay. From one to five feet of till was encountered under the lacustrine sediments. Shale bedrock was encountered from eight to 20 feet below ground surface, the deepest location being at Well P5.

Figure 9 presents a topographic map of the top of the Utica Shale under the site. The contours were constructed from boring log information contained in Appendix C. From Figure 9 it can be seen that the bedrock surface dips gently to the southwest, in the same direction as the flow of ground water determined from preliminary Confirmation Stage water level data. Water Table flow gradients most often mimic Ground Surface Topography, but at Landfill No. 1 this is not the case. This suggests that some other phenomenon is exerting a control over ground water flow directions in the vicinity of Landfill No. 1. The bedrock may represent a permeability boundary to vertical infiltation of ground water which defines ground-water gradients, and that ground water will flow literally "down hill" over the bedrock surface, as opposed to downgradient under more normal ground-water flow conditions.

5.3.3 Ground Water Flow Evaluation

Tables 2 and 5 contain ground water elevation data, as measured on 18 April 1982. Surveyed elevations were keyed to Well W-5, an arbitrary benchmark for relative elevations. The elevation of Well W5 was based upon a nearby spot elevation from the base facilities plan map. Water level elevations from all nine Landfill No. 1 wells were used to construct the water table contour map shown in Figure 10. Contouring of this map took into consideration that the water table should also intersect the elevations of both the seep and Six Mile Creek. From Figure 10 it can be seen that the ground-water flow direction is to the southwest toward the creek from the landfill. Several other observations may be made based upon Figure 10.

- The average gradient across the site (head drop versus distance of flow) is approximately 0.02 feet per foot.

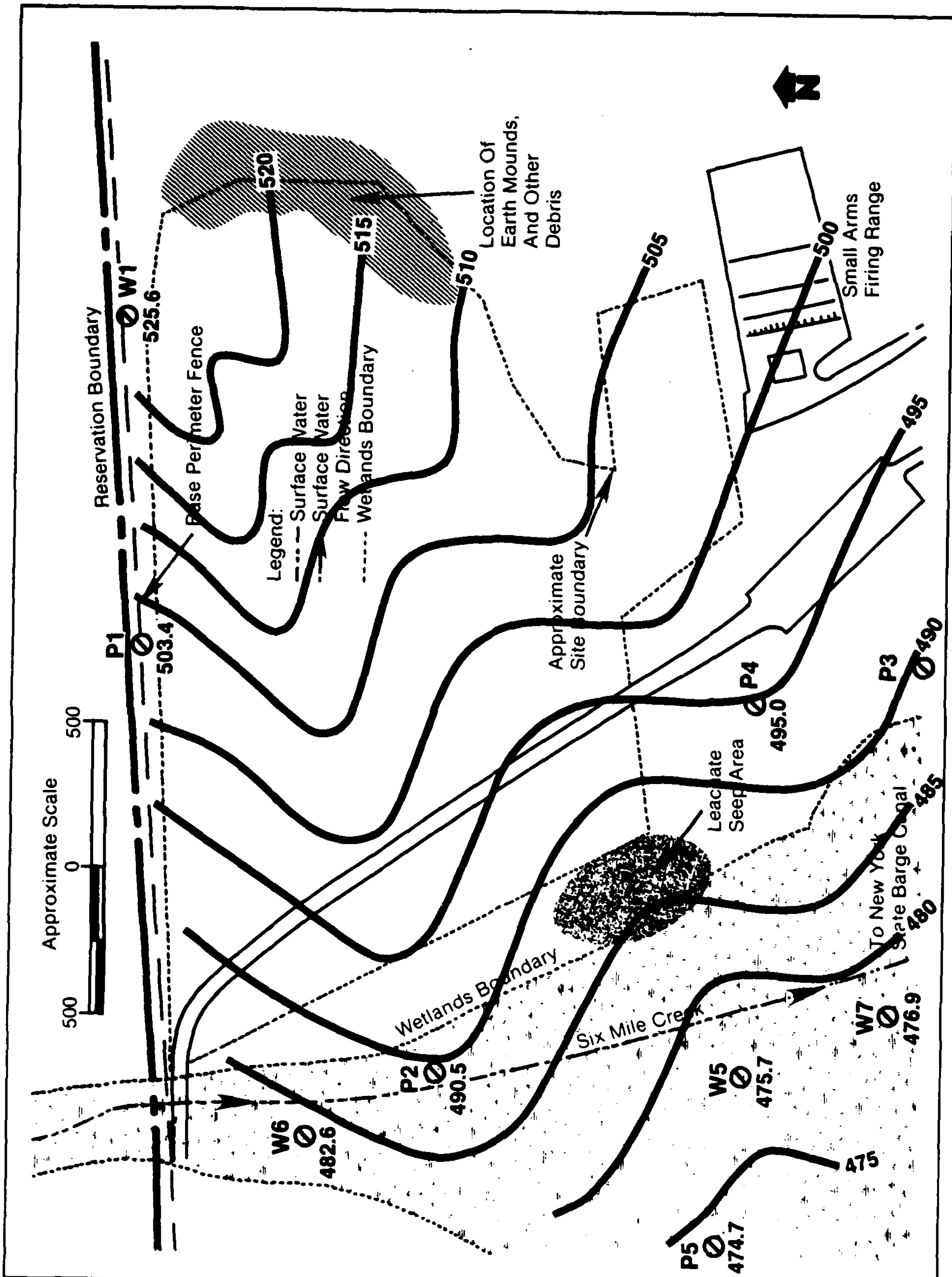

FIGURE 9 TOPOGRAPHIC MAP OF THE TOP OF THE UTICA SHALE, LANDFILL NO. 1, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

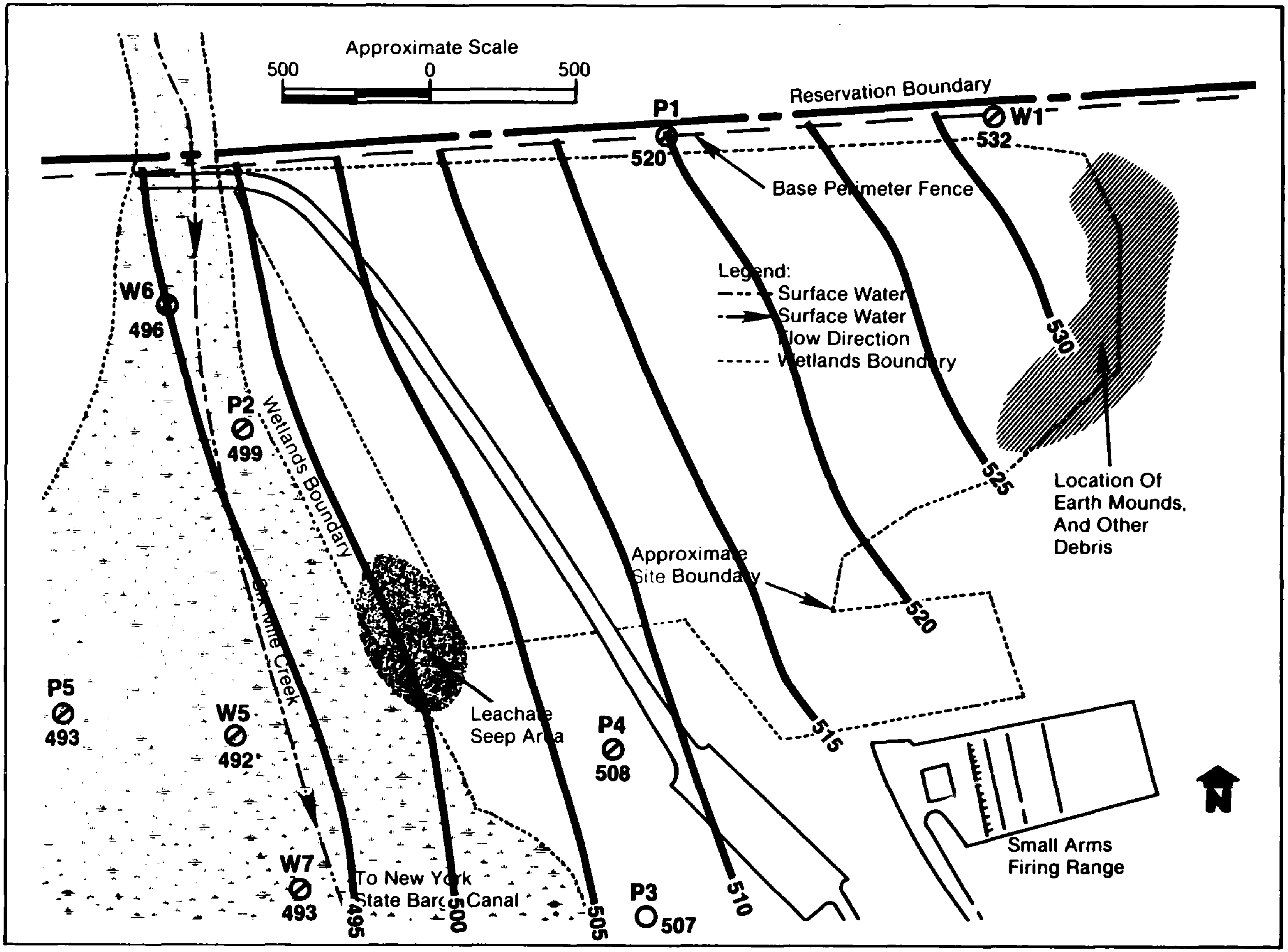

FIGURE 10 MAP OF WATER TABLE CONFIGURATION, LANDFILL NO. 1, 18 APRIL 1982, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

- Ground-water levels in the wetland wells (W5, W6, W7 and P5) were lower than the creek surface indicating a discharge gradient from the creek to the water table to the southwest. This is an expected condition at the onset spring-thaw conditions, but it is probably not typical for other seasons of the year. With the Creek and Aquifer under the hydraulic conditions as measured in April, 1982, flow lines do not converge upon the Creek, with the Creek acting as a hydrodynamic barrier to further migration, but will pass beneath the Creek allowing migration to occur. During periods of higher water Table elevations in these wells, the Creek will act as an effective hydrodynamic barrier to further contaminant migration in the water table.

- There is a bend in ground-water surface contours and a compression of gradients near Well P2. Ground-water elevations in Wells P3 and P4 are similar to the outflow elevation of the seep, while the water level in Well P2, approximately 50 feet from the seep, is approximately seven feet lower. This indicates a permeability barrier to the west of the seepage outflow, and this is consistent with the transition between disturbed conditions near the landfill and undisturbed conditions to the creek side of the landfill. Since ground water flows preferentially in zones of least resistance (higher permeability) more water will flow through disturbed zones, as represented by Landfill No. 1. When ground water flowing in relatively higher permeability encounters a zone of relatively lower permeability, as represented by the undisturbed area near well P2, water levels in the higher permeability zone will mound, as shown at the seep. The relatively low permeability, undisturbed zone near Well P2 is an effective barrier to retard leachate migration laterally in the direction of Well P2.

- There is no flow gradient indicating off-base migration of any contaminants which may be in the ground water at Landfill No. 1.

5.3.4 Aquifer Characteristics Testing

During development pumping of the monitor wells shortly after construction it became clear that only Well P4 could be pumped for a sufficiently long time to conduct a pump test, as described in Section 4.2.7. A short duration (90 minutes) pump test was conducted on Well P4. Normally this is not a long enough test duration for water table conditions--however, no other monitor wells were near enough to monitor for a longer duration test, considering the very thin nature of the water table aquifer. Therefore, Well P4 was pumped only long enough to establish a relatively constant drawdown head, and then pumping was terminated and head recovery was monitored. Three other wells, P2, P3 and W5, were selected for slug testing as described in Section 4.2.7. Transmissivity of the aquifer was calculated from the Well P4 pump test data, using the relationship:

$$T = \frac{2.30Q}{4 \pi S_1}$$

Where T = Transmissivity (Ft^2/Minute)
Q = Pumping Rate (Gallons/Minute)
S_1 = Residual Drawdown over One Log Cycle of Time (Feet)

Hydraulic conductivity of the aquifer was determined from slug test data on Wells P2, P3 and W5, using the method of Bouwer and Rice. Transmissivity and hydraulic conductivity are directly comparable, since transmissivity is equal to the product of hydraulic conductivity and aquifer saturated thickness. Saturated thickness is known from comparing well construction data with water level data. The analysis of the pump and slug test data is contained in Appendix E, and the results are summarized in Table 6.

From Table 6 the following conclusions may be drawn:

- Hydraulic conductivities determined for Wells P3 and W5 are the same at 0.002 feet per minute, a result which would be consistent with results expected for fine to medium grained aquifer materials containing a very small silt and clay fraction.

- The hydraulic conductivity value obtained for Well P2 was an order of magnitude lower (0.0003 ft/min) than for Wells P3 and W5. This result would be consistent results expected for silty fine sand aquifer materials.

Table 6

Summary of Aquifer Characteristics Test Results
From Landfill No. 1 Wells

Well	Test Method	Parameter Measured	Aquifer Thickness In Feet	Hydraulic Conductivity Feet/Minute	Transmissivity $Feet^2$/Minute
P2	Slug/Recovery	Hydraulic Conductivity	7	0.0003	0.0021*
P3	Slug/Recovery	Hydraulic Conductivity	11	0.002	0.022*
W5	Slug/Recovery	Hydraulic Conductivity	5	0.002	0.010*
P4	Pumping	Transmissivity	12	0.1*	1.2

*Calculated

- The transmissivity (1.17 ft^2/min) and calculated hydraulic conductivity (0.1 ft/min) for Well P4 were several orders of magnitude higher than those of Wells P3 and W5. This result would be consistent with results expected for clean medium to coarse grained sands.

Sediment samples from screened intervals of selected wells were submitted to the laboratory for particle size analysis. The purpose of these analyses was to provide a cross-check, on the aquifer characteristics results obtained from well tests. The results of these analyses are presented in Appendix F, and are summarized below.

The results of these analyses indicate that the screened intervals of Wells P2, P3 and P4 contain sediments of roughly similar grain size distribution. Median grain sizes for the three screened intervals range from 300 microns (fine sand) in Well P2, to 800 microns (medium sand) in Well P3. All three wells have a D-90 grain size of about 140 microns in the fine sand range. This result would be consistent with a hydraulic conductivity on the order 0.002 feet per minute, such as was obtained on Wells P3 and W5. The results obtained for the particle size analyses on samples from Wells P2 and P4 appear to be in conflict with the results of the aquifer tests--the aquifer test result for Well P2 appears to be too low, and the result for Well P4 appears to be too high. The most likely explanation for this apparent conflict lies in the very heterogeneous nature of the aquifer materials. Well P2 may be screened in a sand lens surrounded by finer grained and less permeable materials, while Well P4 may be in direct hydraulic connection with coarser and more permeable materials adjacent to the well.

The distribution of measured permeabilities in the water table aquifer indicates that leachate from Landfill No. 1 would migrate preferentially in a south-southwesterly direction away from the Landfill. Based upon the hydraulic conductivities measured in Wells P3 and W5, and upon the measured average gradient across the site, leachate seepage velocities on the order of 0.25 feet per day can be expected during portions of the year when the water table and creek are configured as in April, 1982. During portions of the year when the creek acts as an hydrodynamic barrier, seepage velocities in a south-southwesterly direction away from the landfill could be expected to be lower than this value.

5.3.5 Ground Water Sampling and Analyses

On 28 April 1982 a complete round of water quality samples was taken from all nine monitoring wells at Landfill No. 1. Sampling was accomplished as described in Section 4.2.6.1 of this report. The list of analytes selected for Quantification Stage analysis was based upon the results of Confirmation Stage testing, was considerbly shorter than for the Confirmation Stage, and included the following analytes:

- EPA Priority Pollutant List Volatile Organics Fraction (VOA)
- Total Organic Carbon (TOC)
- Chromium (Total Soluble)
- Zinc
- Iron
- Calcium

Samples were transported to the WESTON Laboratory on ice, and were extracted and analyzed in accordance with Standard USEPA protocols as noted in Section 4.2.6.3 of this report. Table 7 contains the results of the Quantification Stage ground-water chemistry analyses. For comparison purposes, Appendix G contains a listing of USEPA Safe Drinking Water Standards.

From the data in Table 7 several conclusions may be drawn:

- The results of analyses on Wells W1 and P1, combined with the water table map contained in Figure 9, appear to confirm that no contaminants are migrating off-base in the groundwater. However, both wells are very close to the boundary of the landfill, and considerable scatter in the zinc data from Well W1 and the elevated TOC datum from Well P1 make a definitive conclusion impossible at this time.
- Slightly elevated zinc and calcium in Well P4 indicates the potential presence of a diluted lobe of leachate to the southeast of the present seep, and in the direction of the highest measured permeability at Landfill No. 1.

Table 7

Results of Quantification Stage Ground Water Quality Analyses, Landfill No. 1

Well	TOC (mg/l)	Cr (Sol)[1] (mg/l)	Fe (Sol) (mg/l)	Zn (Sol) (mg/l)	Phenols (mg/l)	VOA[2] (ug/l)
W1	<1.0	<0.05	<0.05	4.30	31.9	<10
W5	13.0	<0.05	4.00	<0.02	125.0	23 (ethyl benzene)
W6	3.5	<0.05	<0.05	<0.02	74.7	<10
W7	25.0	<0.05	<0.05	<0.02	89.9	<10
P1	12.0	<0.05	<0.05	<0.02	39.4	<10
P2	31.2	<0.05	1.18	<0.02	123.0	<10
P3	24.4	<0.05	<0.05	<0.02	46.4	<10
P4	<1.0	<0.05	<0.05	0.04	54.1	<10
P5	22.9	<0.05	2.40	<0.02	75.0	<10
Detection Limits:	1.0	0.05	0.05	0.02	0.1	10

Notes: [1]Sol indicates dissolved metals.
[2]VOA indicates USEPA Priority Pollutant List Volatile Organic Compounds (see Appendix D).

- Elevated TOC levels noted in most wells in the wetlands area may be due to infiltration of surface water from marshes, where TOC is naturally high from the decomposition of marsh vegetation.

- Elevated calcium and iron in wells W5, W6, W7, P2, P3, and P5 may indicate the presence of a diluted plume of leachate in the wetland area southwest of Six Mile Creek. The detection of ethylbenzene in Well W5 would appear to confirm this, although the lack of ethylbenzene in any of the other wells around it indicates that this occurrence is isolated. No definitive conclusion is possible at this time.

- Additional water quality monitoring for Quantification Stage analytes should be done on the nine landfill No. 1 wells. If the results of such additional monitoring fail to resolve the questions raised above, additional monitor wells may be needed for sampling and analysis. If these additional data verify the Quantification Stage results concerning the isolated nature and low concentration of ethylbenzene in Well W5, then based upon our experience with similar types of sites WESTON would conclude that the diluted plume southwest of Six Mile Creek represents a situation of no major environmental concern. This is especially true since there are no known potable water supply wells in either the water table or the Utica Shale Aquifers within at least one mile of the landfill.

5.3.6 Surface Water Flow and Water Quality

The purpose of measuring surface water flows in Six Mile Creek was to assess the potential direct impact of leachate seepage upon the creek. Direct instantaneous flow measurements were made of the two seepage streams entering Six Mile Creek (Sample LS) and of the creek itself at the three stream sampling locations (Samples S1, S2, S3) shown on Figure 11. The seepage streams were measured by timing flow through a small weir. The creek flow rates were determined by measuring flow velocities across measured cross-sectional areas at each sampling station.

The measurements were made during a period of moderately increased flow resulting from a rainstorm. The creek, however, was not above its banks. Calculations for stream flow measurements

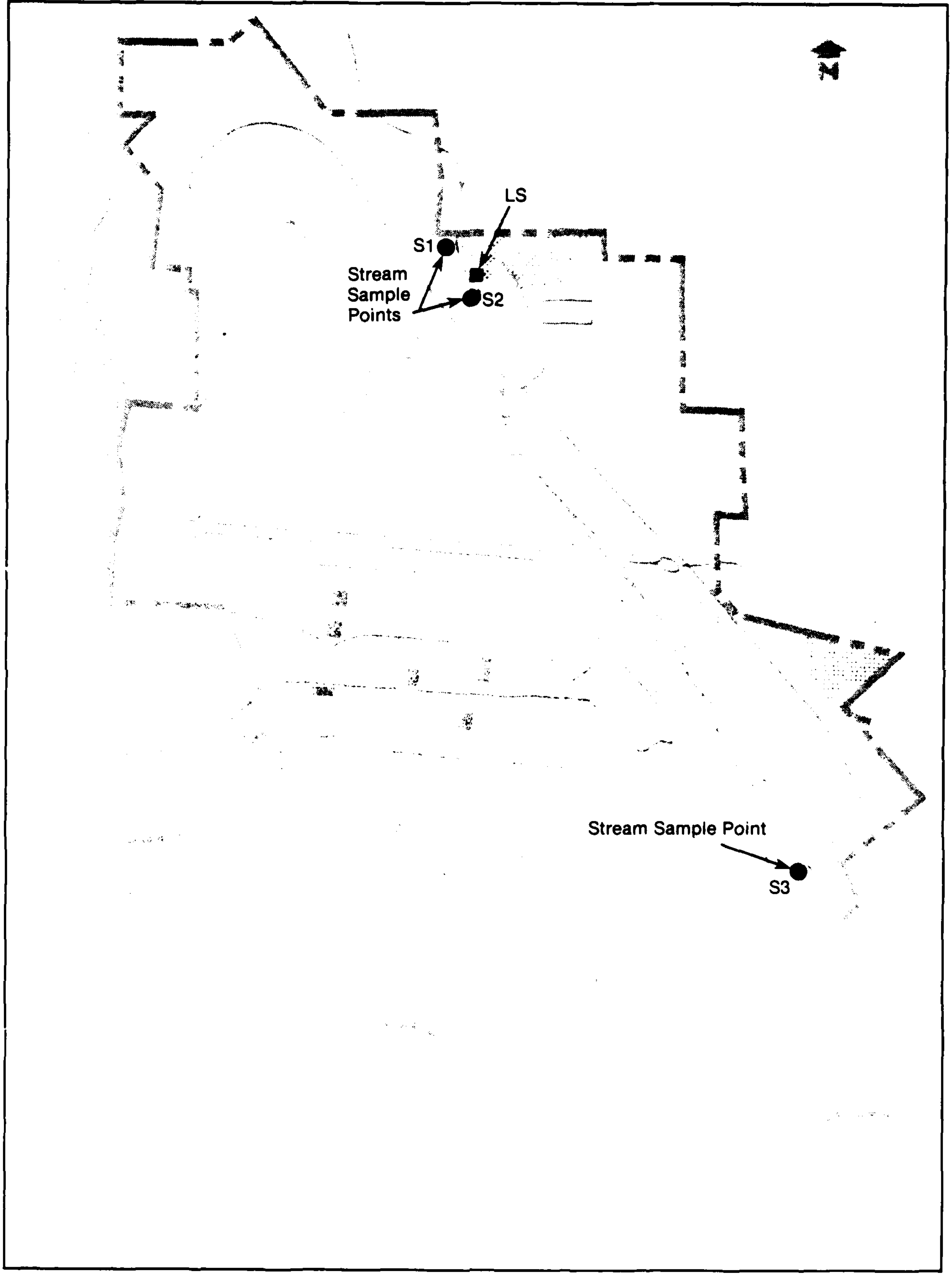

FIGURE 11 LOCATIONS OF FOUR QUANTIFICATION STAGE SURFACE WATER SAMPLING SITES, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

are presented in Appendix H and the results of all measurements are summarized in Table 8. Creek flow at the two locations measured at Landfill No. 1 averaged 4.2 cfs (2.72 mgd). The two readings were within 15% of each other, a precision which is well within the margin of error for such measurements. Flow measured at the culvert where Six Mile Creek exits the base, at the southeastern end of the runway, was measured at 5.8 cfs (3.76 mgd).By contrast, the combined flow of the two coalesced leachate rivulets at the toe of Landfill No. 1 was less than 0.1 cfs (0.06 mgd). This rate of leachate flow was relatively high, due to the recent rainstorm--others have estimated the leachate seepage rate at about five gallons per minute (7,200 gallons per day). If the higher, measured flow rate were typical of the leachate seep, this volume of leachate represents about 1.4 percent of the instantaneous flow rate of Six Mile Creek at the seep. At the Six Mile Creek point of discharge from the base the total discharge of leachate seepage is about one percent of the total instantaneous flow of the creek. In other words, for the time measured the leachate discharged to the Creek experiences approximately an instantaneous 75-fold dilution, and by the time the creek departs the base this dilution factor raises to about a total of a 100-fold dilution. The implication of this finding is: 1) if a compound to be detected at the exit point from the base has a detection limit of 10 parts per billion (ppb), and 2) if that compound is contributed to the creek solely by landfill leachate, then 3) the compound would have to be present in the leachate at a concentration of about 1,000 ppb in order to be detected at all downstream of the discharge. This assumes the same flow ratio of leachate seepage to stream flow throughout the year. No data are known to be available documenting 7-day, 10-year low flow of Six Mile Creek, and the value cannot be calculated on the basis of a single set of instantaneous measurements. If the ratio of spring seepage base flow to the stream base flow increased by a factor of three, the concentration of a contaminant would have to be at least 250 ppb to be detectable immediately downstream of the confluence of the seep with Six Mile Creek.

In order to test this scenario, surface water quality samples were taken at both leachate seeps, and at all three surface water gaging stations. Samples were taken in accordance with the procedure described in Section 4.2.6.2 of this report. The samples were transported to the WESTON Laboratory on ice, and were analyzed for the shortened list of Quantification Stage parameters enumerated in Section 5.3.5. Table 9 contains the results of those analyses. Of the Volatile Organics analyzed for in the leachate, only toluene was detected at 21 ppb--an insufficient concentration to have a local detectable trace in Six Mile Creek at the seep discharge point. The leachate TOC levels were elevated over background surface water levels (assuming

Table 8

Summary of Stream Flow Measurements,
Six Mile Creek, Griffiss Air Force Base

Location	Date	Instantaneous Flow (cfs)	Instantaneous Flow (mgd)
S-1, Six Mile Creek, Station 1, Bridge Upstream from Landfill No. 1	4-27-82	4.4	2.85
S-2, Six Mile Creek, Station 2, Downstream from Landfill No. 1 Seeps	4-27-82	3.9	2.53
S-3, Six Mile Creek, Station 3, Downstream Exit from Base Near Family Center	4-27-82	5.8	3.76
LS, Leachate Seeps (combined)	4-27-82	<0.1	<0.06

Table 9

Results of Quantification Stage Surface Water Quality Analyses - Landfill No. 1

Sample Site	TOC (mg/l)	Cr(sol)[1] (mg/l)	Fe(sol) (mg/l)	Zn (sol) (mg/l)	Ca(sol) (mg/l)	VOA[2] (mg/l)
Seep 1 (Site LS)	55.3	<0.05	<0.05	0.02	147.0	<10
Seep 2 (Site LS)	74.3	<0.05	1.60	<0.02	156.0	21 (Toluene)
Six Mile Creek (Site S1)	2.0	<0.05	<0.05	<0.02	10.1	<10
Six Mile Creek (Site S2)	2.3	<0.05	10.46	<0.02	35.5	<10
Six Mile Creek (Site S3)	3.3	<0.05	0.27	<0.02	14.7	<10
Detection Limits	1.0	0.05	0.05	0.02	0.1	10

[1](sol) indicates dissolved metals.

[2]VOA indicates U.S. EPA Priority Pollutant List Volatile Organic Compounds (see Appendix D).

that Station 1 at the bridge is representative of background conditions), but are consistent with or only slightly higher than the TOC levels expected to be associated with naturally decomposing vegetable matter in marshy terrain. The leachate seep traverses such a marshy terrain between its rising point and its discharge point to Six Mile Creek. At a dilution factor of about 75 the combined leachate TOC can only raise the TOC level in the creek by about 0.9 parts per million (ppm)--an increase of 0.3 ppm over background was actually detected at the discharge mixing point. In effect, such small variations in TOC data are within the error of quantification for TOC. At Sample Point S2 high dissolved iron was detected. Iron floccules were observed in the stream bed at Station S2, probably representing diffuse water table discharge to the creek. While dissolved iron in excess of 10 ppm is high, local pH conditions probably contribute to keeping this iron in solution locally. This iron value is not inconsistent with iron concentrations in marshy deposits in other areas of the northeastern United States. Toluene constitutes between 6 percent and 7 percent by volume of many commercial gasolines, and is a fairly common constituent of commercially available paint strippers and paint and laquer thinners. In a landfill used dominantly for municipal-type waste and refuse disposal it may not be too surprising to find traces of toluene present from municipal trash disposal. The failure to detect ethylbenzene in the leachate seep is supportive of the conclusion that the dilute leachate plume present in groundwater southwest of Six Mile Creek is an isolated occurrence, and that it is not currently sustained and recharged by leachate migrating away from Landfill No. 1.

From the foregoing analyses, several conclusions may be drawn:

- The leachate from Landfill No. 1 does not appear to be toxic to vegetation.
- High dilution factors render the leachate contaminants virtually undetectable at even short distances downstream on Six Mile Creek.
- Landfill No. 1 appears to have no significant impact upon water quality in Six Mile Creek at the point where the Creek leaves the base.

5.3.7 Ground Penetrating Radar Results

As discussed in section 4.2.3.2 the two primary objectives of the GPR tests were: 1) determine the usefulness of the data in the analysis and understanding of soil and bedrock conditions; and 2) determine whether or not the GPR could delineate the landfill boundaries.

The specific geologic data to be obtained by the GPR was a top of rock profile from the landfill to the creek. In order to accomplish this the GPR traverse must begin at, and periodically intercept, known subsurface conditions (wells) and be continuous. The traverse selected began at Well P5, continued to Wells W5 and P2, and then continued directly uphill to the top of the landfill. The profile produced generally conformed to log data, however, it was not continuous. The lack of continuity was due to wet areas adjacent to the creek, to the creek itself, and to heavy vegetation on the hill. Due to the lack of continuity the GPR data was of limited use. However it did demonstrate that top of rock can be located by an unobstructed continuous traverse. Figures 12 and 13 present examples of GPR profiles from Landfill No. 1 that show distinct soil and lithologic interfaces.

The second objective of the GPR test was to determine whether or not the boundaries of the landfill could be delineated. Based on past experience WESTON has observed that natural or undisturbed areas exhibited profiles with continuous interfaces in contrast to disturbed areas such as landfills which exhibit discontinuous or disjointed interfaces. Several GPR traverses, were run through the landfill all of which produced profiles similar to the one shown in Figure 13. Comparing the profiles shown in Figures 12 and 13 it can be seen that areas within the landfill produce profiles distinctly different from adjacent undisturbed areas. Therefore, it has been successfully demonstrated that the GPR can accurately delineate the boundaries of the landfill. Delineation of the landfill boundaries will be helpful in determining the area that will be involved in any necessary remedial action.

5.4 CONCEPT ENGINEERING EVALUATION OF LANDFILL NO. 1

5.4.1 General

The remedial action alternatives have been grouped into two categories according to level and degree of action as follows: The first category, Minimal Action, includes those basic activities which could be applied as a minimum level of environmental control. In general, implementation of the Minimal Actions should reduce potential future environmental contamination but will not significantly contribute to the cleanup of any contamination which may already have occurred. Continued monitoring

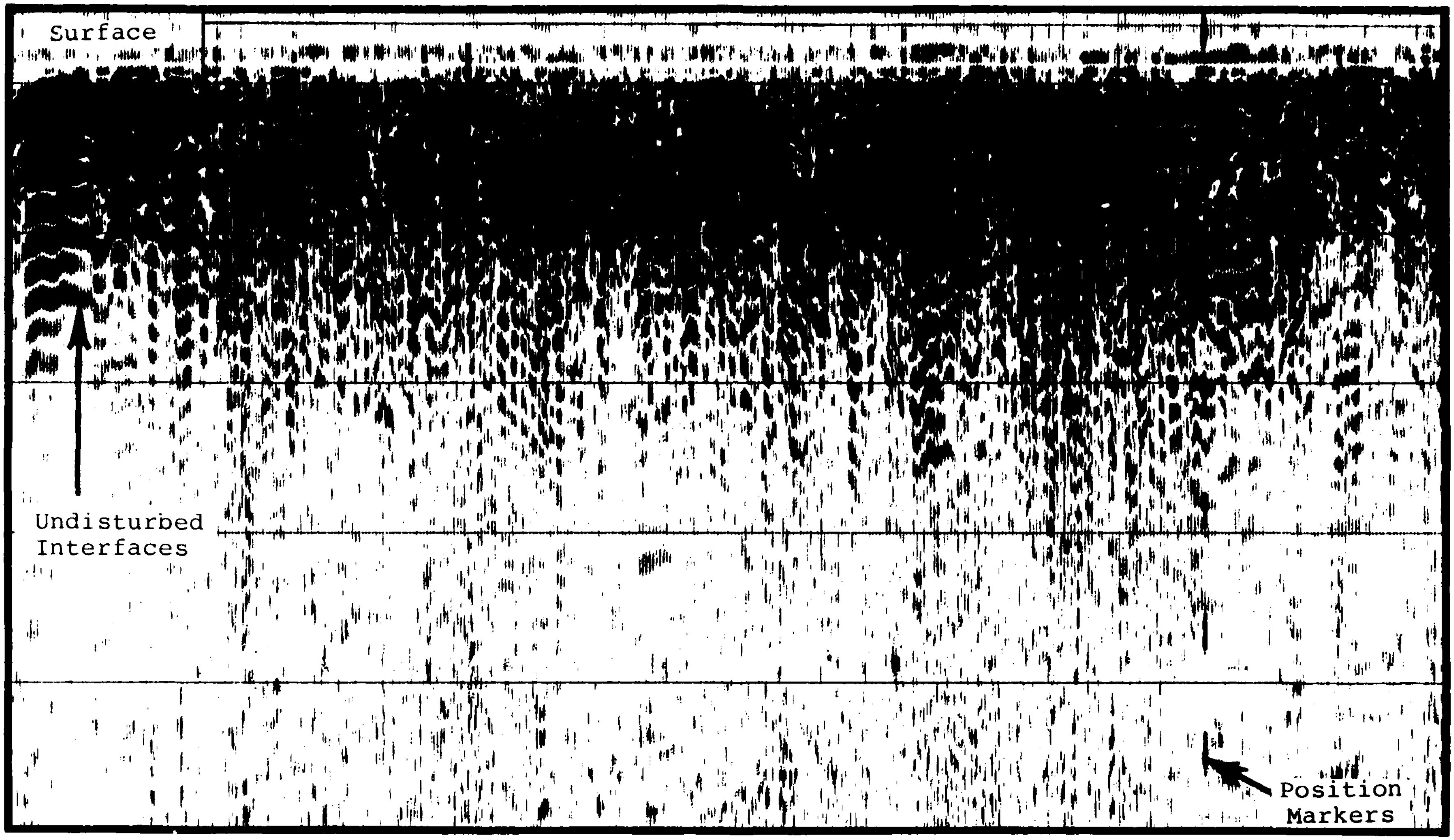

Figure 12: Ground Penetrating Radar Profile of A Disturbed Area, East Side of Landfill No. 1, Griffiss Air Force Base, Rome, New York

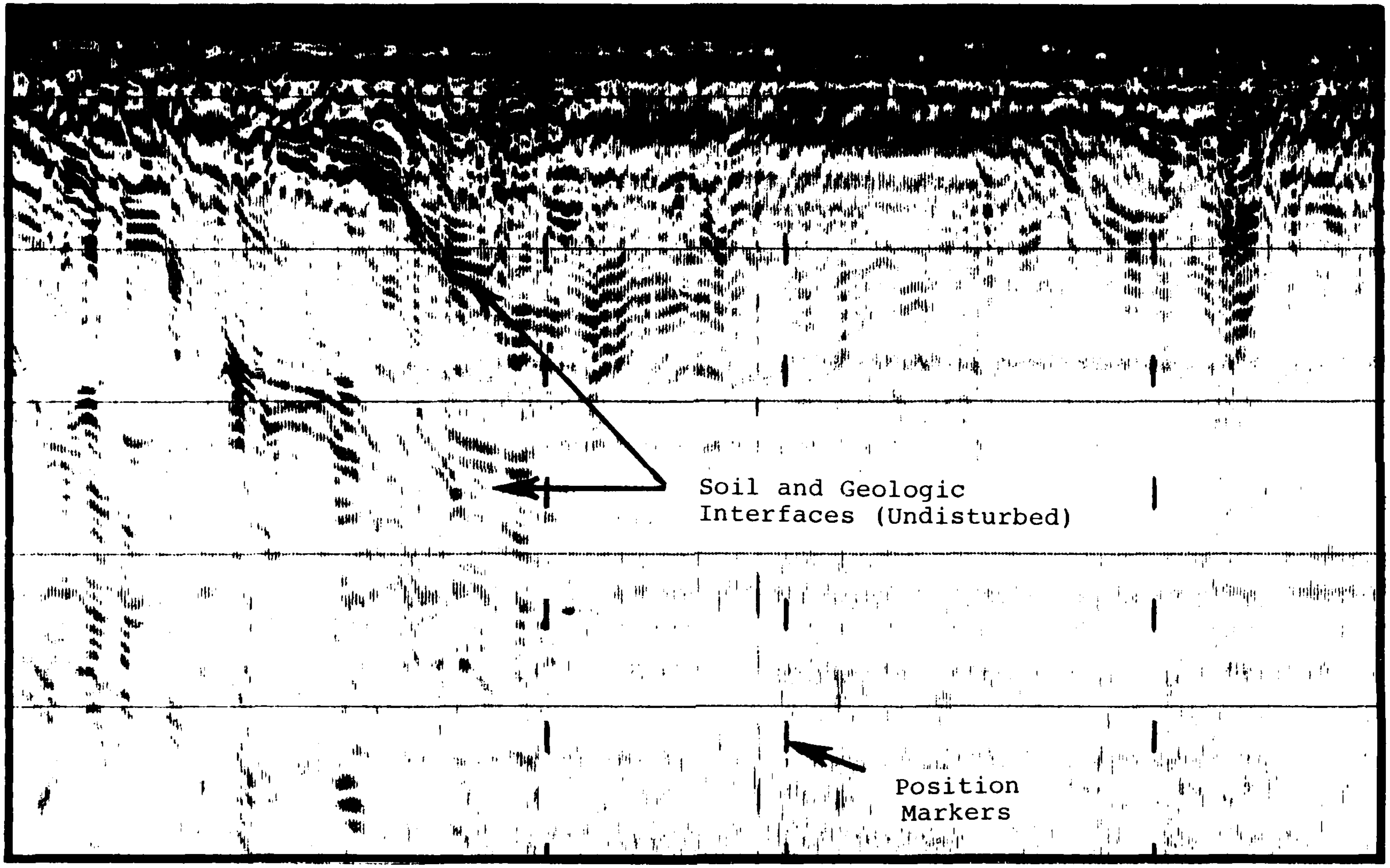

Figure 13: Ground Penetrating Radar Profile of an Undisturbed Area, Staging Area Adjacent to Landfill No. 1, Griffiss Air Force Base, Rome, New York

activities are an important part of the Minimal Actions outlined. If this monitoring shows additional future contamination, it may be necessary to implement one or more of the Additional Actions to further control the site. The Additional Actions are more complex and costly than those activities identified as Minimal Actions.

The New York State Department of Environmental Conservation (NYDEC) requires that a sanitary landfill which has been closed in the past must have been closed in accordance with regulations which were in effect at the time when that landfill was closed. If it was not closed properly in accordance with the regulations in effect at the time of closure, then it must be closed in accordance with current regulations. Municipal waste landfill closure regulations in place during the early 1970's required emplacement of a final cover and implementation of a monitoring program, but no details were provided in the regulations as to specifications for these requirements. Since Landfill No. 1 had a cover installed at closure, and a monitoring program consisting of daily security inspections was implemented, Landfill No. 1 appears to have been closed in compliance with then-existing regulations. Current regulatory requirements of New York were considered in the development of the Minimal and Additional Actions. Exerpts of the current governing regulations are contained in Appendix I.

5.4.2 Remedial Action Alternatives for Landfill No. 1

More extensive remedial actions might be applicable to Landfill No. 1 (shown in Figure 6) than to the other landfill sites due to the presence of a leachate seep at the toe of the fill near Six Mile Creek. The Minimal and Additional Actions for Landfill No. 1 are summarized in Table 10. The Minimal Action does not address treatment of the seep conditions for two reasons:

- The quality of the leachate seeping from the landfill does not appear to be a cause for major concern at thepresent time. As shown in Table 9, iron, zinc, and a volatile organic (toluene) were detected at low levels relative to human health criteria. At this low level toluene will probably volatilize by the time the Six Mile Creek leaves the base. Calcium and TOC levels were slightly elevated.

Table 10

Remedial Action Alternatives for Landfill No. 1
Griffiss Air Force Base, Rome, New York

MINIMAL ACTION OPTIONS

- * Clean up and properly dispose of exposed waste, exposed drums, wind-blown refuse and charred debris noted during field reconnaissance.
- Eliminate trail bike paths to reduce "wear and tear" on the landfill surface.
- Clear the landfill surface of volunteer vegetation, while leaving trees planted as part of the reforestation program undisturbed. Other areas should be cleared to facilitate placement of a partial cap.
- * Backfill surface depressions, compact and regrade the surface to provide positive drainage, provide a firm base for the final cover, and ensure that ponding of precipitation does not occur in the future.
- Apply a cover consisting of a six-inch clay cover and an 18-inch topsoil layer, only in non-forested areas, in order to reduce infiltration and provide support for new vegetative cover.
- Vegetate the cover using mulch stabilization to provide protection against erosion and enhance evapotranspiration of precipitation stored in the soil zone.
- Continue surface water and groundwater monitoring program to document leachate migration, if any. Wells W1, W5, W7 and P2 should be used for this monitoring program, as a minimum.
- Implement a regular inspection program to document the effectiveness of the remedial action.

ADDITIONAL ACTION ALTERNATIVES:

Depending upon environmental impacts and the results of the Minimal Action Options, the feasibility of the following actions should be investigated:

- Physical isolation of the spring, which would require a detailed site investigation to determine the source of the spring, and the pathways of migration of any contaminants detected. Waste around the spring would be excavated to eliminate landfill leachate as a source of spring recharge.
- Leachate treatment may become necessary if surface or groundwater or leachate quality deteriorates significantly. A treatability study would be the first step in this alternative.
- Installation of an area-wide multi-layered cover, as shown in Figure 14, may become necessary if excessive infiltration and subsequent leachate generation exacerbate the current low level of contamination off-site. Such a cover would extend over the entire landfill area, including currently reforested sections.

*Denotes minimum actions specified in current requirements of the New York Department of Environmental Conservation.

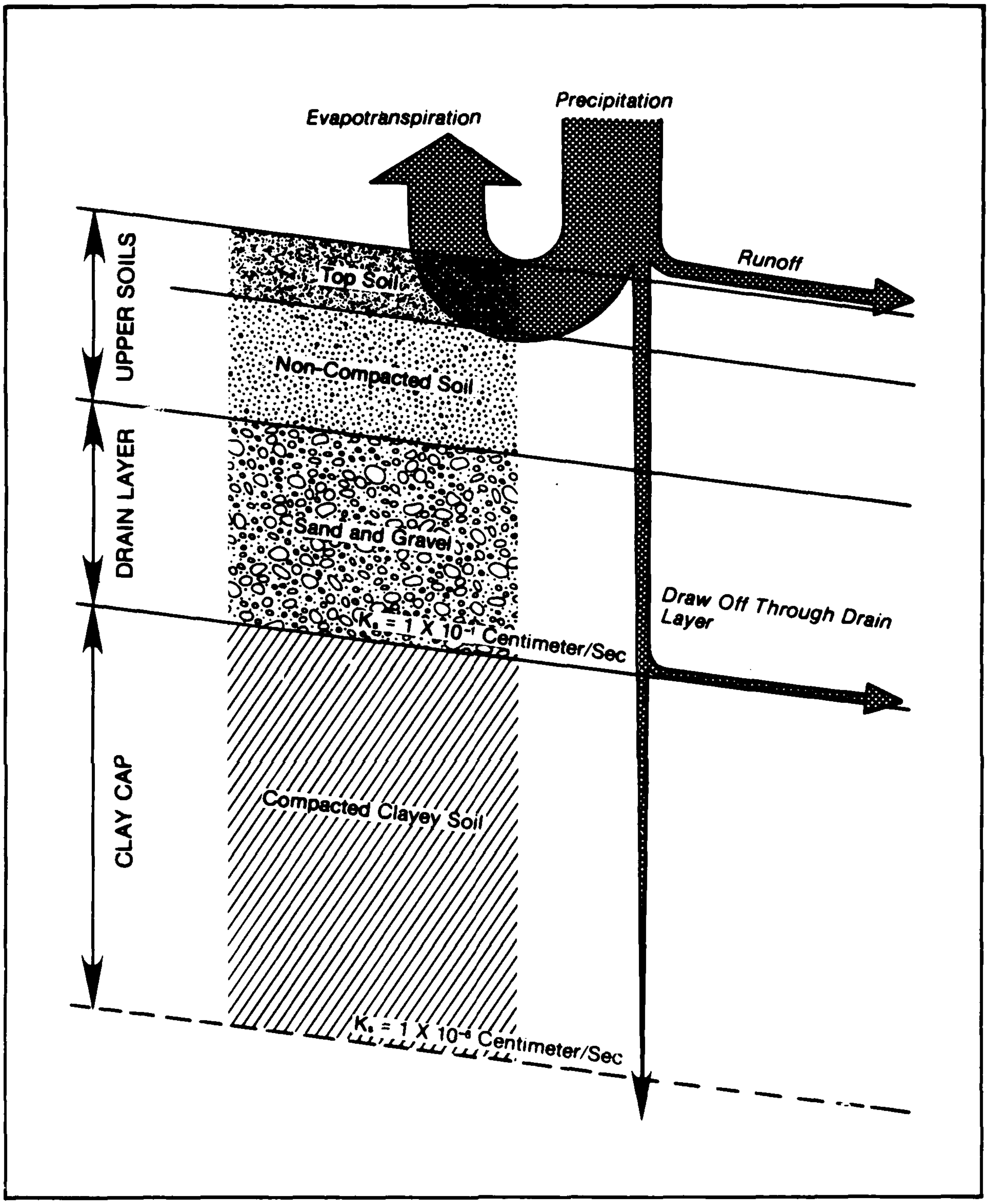

FIGURE 14 SCHEMATIC OF A MULTI-LAYERED LANDFILL COVER SYSTEM

- The quantity of leachate entering Six Mile Creek is small compared to the stream flow. Since the leachate contamination level is so low, it is greatly diluted by stream flow. No significant water quality difference (other than iron at Station S2 as noted above) were noted among the stream sampling points.

If the suggested continuing monitoring activities indicate that either of these conditions has changed (i.e. the leachate quality or stream quality degrades, or the leachate quantity increases) or if the aesthetics of the seep area are to be considered, it may be necessary to implement one ore more of the Additional Actions to address the problem. Table 10 summarizes the Minimal and Additional Action Alternatives for Landfill No. 1. Actions which would be required for compliance with existing landfill reguulations are indicated in Table 10.

Analytical data from the wells surrounding Well W5 indicate that area-wide groundwater cleanup should not be a primary alternative at this time. The occurrence of ethylbenzene in Well W5 appears to be an isolated occurrence unsupported by new contributions of leachate from Landfill No. 1. If additional chemical monitoring continues to show only low levels and localized areas of contamination, then we would recommend that future area-wide groundwater cleanup not be considered further as an Action Alternative. The Minimal Action is intended to reduce the infiltration which enters the landfill and subsequently recharges the leachate seep. Contact of infiltration with the buried waste contributes to leachate generation. The cover would be installed only in those areas where heavy reforestation has not taken place. Ground penetrating radar (GPR) might be used to more accurately determine the boundaries of the filled area prior to placing the clay layer. The regular inspection program specified in Table 10 would include:

- Examination of cover for differential settlement and erosion damage.
- Sampling of groundwater monitoring wells, leachate seeps and surface water.
- Checking for possible methane accumulation in nearby storage bunkers.
- Checking for evidence of any unauthorized entry and dumping.

A typical inspection frequency would be semi-annually for the first two years after completion of remedial action, and annually thereafter if no increased contamination levels occur. Table 11 summarizes a typical chemical monitoring program for a closed New York State sanitary landfill. A program of this type would be applicable to Landfill No. 1 at Griffiss Air Force Base since it was used primarily as a sanitary landfill when it was in active operation. The analytes listed reflect a general listing of tests which should detect leachate from a typical sanitary landfill.

The monitoring program should be continued for a minimum of five years. At the end of the first five years, the results should be evaluated and a decision made concerning possible future monitoring. If no contamination has been found it may be possible to discontinue the program. It may also be decided to continue the program, either as is, or on a reduced scale.

Unauthorized dumping is an important concern at this site due to its remote location. There is evidence, such as burned areas littered with discarded chemical cans and areas of discoloration, that suggests that such activity has recently occurred at Landfill No. 1. One speculative but unverifiable explanation of the low-level presence of a volatile organic compound such as ethylbenzene in Well No. 5 could be a past unauthorized dumping incident in the vicinity of that well.

If future sample analyses or visual inspections indicate that excessive contaminant migration is occurring, one or more Additional Actions might be required. Prior to implementation of any Additional Actions, a detailed site investigation should be undertaken to define more precisely the scope of the problem. A leachate treatability study would be needed in order to define an appropriate treatment scheme prior to implementing an option to collect and treat leachate. Such a scheme might consist of simple aeration to volatilize any organics, and to provide a crude level of biological treatment.

Table 11

Typical Groundwater Quality Monitoring Program for A Sanitary Landfill in New York State

Semi-Annual Analyses	Annual Analyses
Chloride (Cl	Metals - Fe (sol) - Zn (sol)
Hardness (as $CaCO_3$)	Nitrate (NO_3)
Phenolic compounds (as phenol)	Sulfate (SO_4)
Total Dissolved Solids (TDS)	Volatile Organics - Benzene - Ethylbenzene - Chlorobenzene - Toluene - Xylene - Trichloroethylene
COD	
TOC	
pH	
Specific Conductance	

Wells to be samples under this program would include, as a minimum, W1, W5, W7 and P2.

If future inspections indicate that excessive infiltration is occurring, then a multi-layered cover system, such as is illustrated in Figure 14, might be considered. The purpose of the upper topsoil layer of such a cover system is to support vegetation, which, in turn, promotes evapotranspiration. Beneath the topsoil, the layer of non-compacted soil (native to the area) aids in supporting vegetation through its water-holding capacity, although this soil layer typically lacks the general composition and nutrients needed to adequately support vegetation. The drain layer serves to divert a large portion of the water which percolates through the upper soil layers; it is effective due its high permeability compared with the extremely low permeability of the clay cap. The water follows the path of least resistance, through the drain layer rather than through the cap. All water which permeates the clay layer will eventually percolate through the waste material and into the environment. However, the multi-layered cover system can be designed to divert as much as 90 percent of all precipitation away from the cap and the waste. This would decrease significantly the rate of leachate generation. Successful implementation of a multi-layer cover system over the entire site would require removal of all trees and vegetation currently growing on the landfill surface. For this reason, installation of a complete multi-layered cover system has been classified as an Additional Action to be considered only if the Minimal Action Options prove to be ineffective in preventing future contaminant generation and migration.

SECTION 6

CONFIRMATION STAGE INVESTIGATIONS
AT OTHER SITES

6.1 GENERAL

The purpose of these additional Confirmation Stage Investigations was to detect whether or not environmental problems existed at several past waste disposal sites at Griffiss. These sites were identified from the Phase I Records Search recommendations and priority ranking analysis. The sites involved in these additional investigations were as follows:

- Landfill No. 2
- Landfill No. 5
- Landfill No. 6
- Landfill No. 7
- Dry Well at Building 301
- PCB Handling Area at Building 112

The locations of each of these sites are shown on the site index map shown in Figure 15. Several specific questions were to be answered as part of these investigations at each site:

- Does an environmental contamination problem exist at the site?
- Does a potential exist for off-site migration of any contamination found?
- Identify alternative actions which may be used to mitigate adverse environmental effects of any contamination found.
- If additional investigative work is required, make recommendations as to the nature and extent of that work.
- Suggest potential ways of restoring the environment to as near a normal level as is practical.

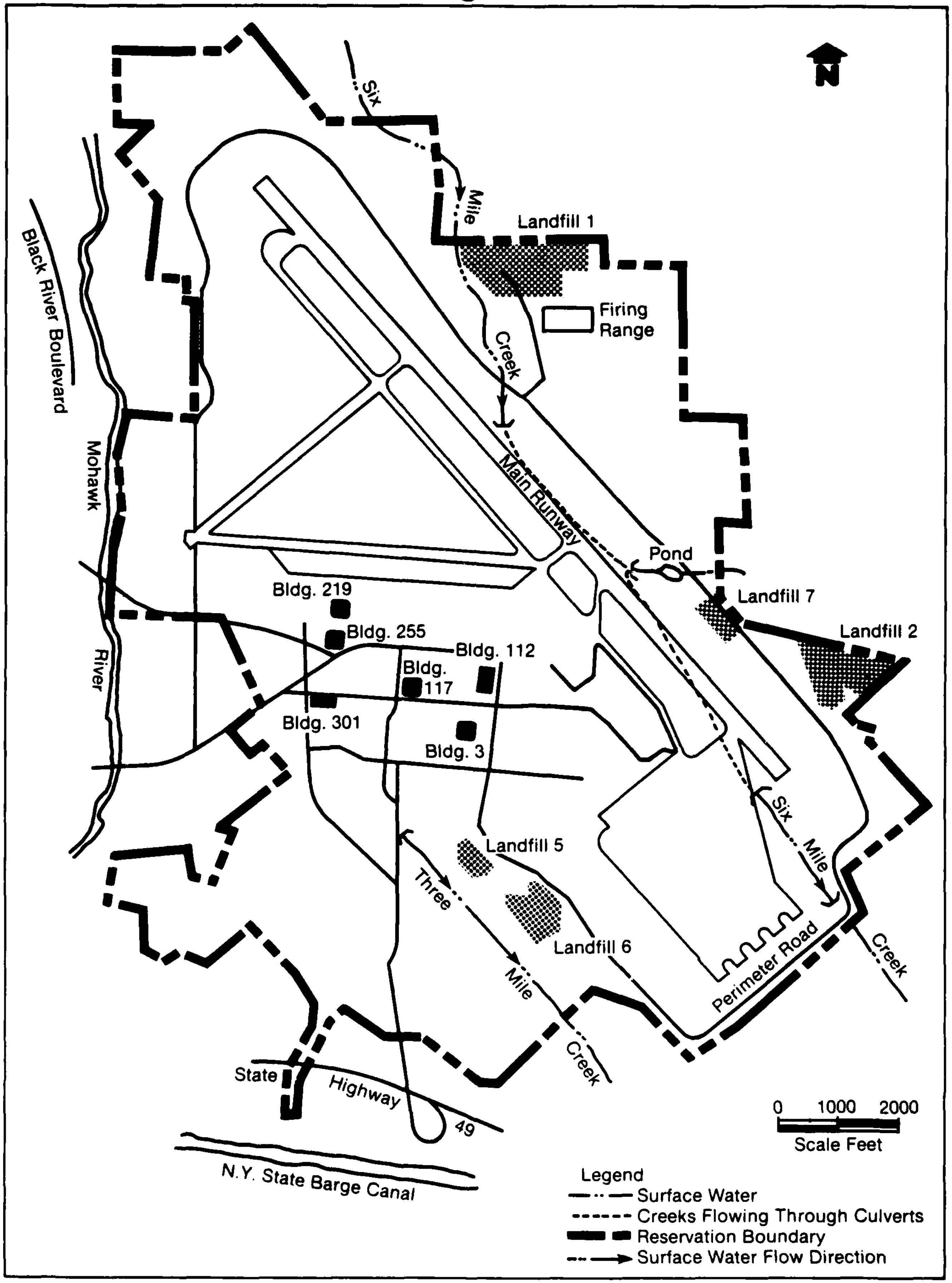

FIGURE 15 LOCATIONS OF LANDFILLS AND DISPOSAL SITES, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

* Suggest a future environmental monitoring program to document environmental conditions at the additional sites.

Based upon the results of the Phase I Records Search, and upon the lower priority ranking of these sites as compared with Landfill No. 1, only Confirmation Stage Investigations were ordered. The results of these investigations would be used to determine whether or not Quantification Stage investigations would be required.

6.2 CONFIRMATION STAGE ACTIVITIES COMMON TO ALL SITES

6.2.1 Site Reconnaissance

The first activity undertaken in these Confirmation Stage investigations was an in-depth field inspection of each site. Results of those inspections are detailed in subsequent portions of this report, under specific site headings. Inspection of vegetation around all the sites revealed almost no stressed or damaged vegetation. Neither was evidence of leachate seeps or chemically discolored soils found.

6.2.2 Remote Sensing Investigation

Aerial photos were obtained from the Intelligence Division, 416 Bomb Wing. These photos clearly depicted all of these additional sites during various years in the past, in both black and white and in thermal infrared prints. Inspection of these photos assisted in determining a better delineated set of boundaries for the sites than was possible from visual reconnaissance. Meticulous examination of the prints, however, detected no evidence of stressed vegetation or thermal irregularities which could have indicated the locations of any subsurface leachate plumes.

6.2.3 Earth Resistivity Surveys

WESTON conducted earth resistivity surveys around all of the sites using a Soiltest Model R-40 Resistivity Meter. The purpose of these surveys was to locate lateral changes in resistivity that may identify subsurface leachate plumes, in order to select sites for the single monitor well authorized for each site. Approximately 2,500 feet of profiles were run on a spot check basis at Landfill No. 2, 5, 6 and 7, and near the Entomology Lab Dry Well (Building 301) using both constant and variable electrode spacings. The surveys focused on most probable downgradient directions. Earth resistivity readings displayed no significant lateral variations thereby rendering the data inconclusive for defining leachate plumes.

Very rainy conditions prevented further work because wet ground affected the reliability of the data. Further efforts in earth resistivity were abandoned for additional sites. The decision was made to install a single downgradient monitor well at each site, as a means of determining the potential for any adverse groundwater impacts which may have been caused by contamination from the sites.

6.2.4 Installation of Monitor Wells

A detailed analysis of topography at each site was undertaken. This analysis revealed the most probable general water table flow direction for each site. One monitor well was placed adjacent to each site, and in a direction indicated by detailed topographic analysis to be downgradient of the site.

All five wells were drilled during November and December 1981, using auger drill equipment, and were drilled and developed in the manner described in Section 4.2.5 of this report. General well construction design followed that shown in Figure 4. Well construction details and boring logs are contained in Appendix C, and well configuration data are summarized in Table 12.

6.2.5 Groundwater Sampling and Analysis

On 22 January 1982, approximately two weeks after completion of development pumping, an initial round of water quality samples was taken from the five monitor wells. Sampling was accomplished as described in Section 4.2.6.1 of this report. Samples were taken for complete analyses of the U.S. EPA Priority Pollutant List, a listing of the compounds of which is in Appendix B of this report. Samples were transported on ice to the WESTON Laboratory, and were extracted and analyzed in accordance with Standard U.S. EPA protocols as noted in Section 4.2.6.3 of this report. Table 13 contains a summary of the data obtained by those analyses. Compounds listed in Appendix D, but not in Table 13, were below quantifiable detection limits.

Soluble chromium was detected in Wells W3, W4 and W8 at levels which could indicate some minor groundwater contamination. A high level of zinc was detected in Well W4 at the Entomology Lab. Copper and phenolic compounds (as phenol) were quantified, but at trace concentrations. Several other compounds were detected in trace amounts, most notably, some of the phthalates. WESTON's Quality Assurance (QA) Officer was of the opinion that a possible QA problem existed, due to the relatively low concentations of those contaminants detected, and due to the relatively high degree of scatter in the QA duplicates analyzed. Prudence indicated that additional analyses were needed, and the QA Officer requested an additional round of samples for a repeat analysis.

Table 12

Monitor Well Construction Data for Five Confirmation Stage Monitor Wells Installed at Landfill No. 2, 5, 6 and 7, and At the Entomology Lab (Building 301), November-December 1981

Well Number	Location Number	Depth (in feet)	Depth Interval of Screen (in feet)	Installation Date	Depth to Water in Feet Below Top of Casing (1-12-82)
W2	Landfill 7	32.0	22.0 - 32.0	11-25-81	20.2
W3	Landfill 2	27.0	17.0 - 27.0	11-24-81	12.7
W4	Entomology Lab	23.5	13.5 - 23.5	11-27-81	16.1
W8	Landfill 5	30.0	20.0 - 30.0	12-18-81	5.8
W9	Lnadfill 6	28.0	18.0 - 28.0	12-18-81	2.5

Table 13

Analyses of Groundwater Samples, Landfill No. 2, 5, 6 and 7, and at the Entomology Lab (Building 301)
11 January 1982

Well Number	Location Number	Cr(sol)[1] (mg/l)	Cu(sol) (mg/l)	Zn (sol) (mg/l)	Phenols (mg/l)	VOA[2] (ug/l)
W2	Landfill 2	<0.05	0.04	0.08	0.006	< 10
W3	Lanfilll 7	0.10	0.04	0.64	<0.005	< 10
W4	Entomology Lab	0.17	0.03	2.49	<0.005	< 10
W8	Landfill 5	0.10	0.09	0.43	<0.005	< 10
W9	Landfill 6	0.08	0.08	0.45	<0.005	< 10
Detection Limits		0.05	0.02	0.02	0.005	10 (each param-eter)

[1](sol) indicates dissolved metals.

[2]VOA indicates U.S. EPA Priority Pollutant List Volatile Organic Compounds (see Appendix D).

On 16 February a second round of water samples was taken from the five wells, in exactly the same manner as previously described except that additional QA samples were taken. Table 14 is a summary of the results obtained from this second round of sampling. For ease of comparison, Table 13 data are also contained in Table 14. Only phenols were detected during this sampling round, and the phenols were detected at levels which are not of immediate environmental concern. No other compounds listed in Appendix D were detected.

6.2.6 Conclusions from the Confirmation Stage

The following conclusions were drawn from the results of the aforedescribe elements of the Confirmation Stage investigations at Landfill Nos. 2, 5, 6 and 7, and at the Entomology Lab (Building 301).

- Any leachate being produced by any of the four landfills is of very low concentration of only a very few compounds.
- No evidence was found for off-site migration of any contaminants from any of these landfills.
- No pesticides were detected in groundwater in the Entomology Lab well.
- It does not appear that a Quantification Stage Investigation will be needed at any of these five sites.
- Additional monitoring should be done during the next two years to verify the conditions.

6.3 LANDFILL NO. 2

6.3.1 Site Evaluation

Landfill No. 2 is located on a topographic high on the eastern edge of the base, as shown in Figure 16. The site covers about sixty acres of high ground set back several hundred yards from Perimeter Road. The landfill had been used for municipal wastes from residents of the base until early in 1981. At the time of this investigation its use had been largely discontinued, although the final trench used for waste disposal has not been completely closed. This trench continues to receive boiled domestic wastes from international flights. At the entrance from Perimeter Road a trench had been constructed across the access road in an attempt to block casual dumpers.

WESTON

Table 14

Summary of all Confirmation Stage Analyses of Groundwater Samples, Landfill No. 2, 5, 6 and 7, and at the Entomology Lab (Building 301)

Well Number	Location Number	Date	Cr(sol)[1] (mg/l)	Cu(sol) (mg/l)	Zn (sol) (mg/l)	Phenols (mg/l)	VOA[2] (ug/l)
W2	Landfill 2	2-16	< 0.05	< 0.02	< 0.05	0.007	< 10
		1-11	< 0.05	0.04	0.08	0.006	< 10
W3	Landfill 7	2-16	< 0.05	< 0.02	< 0.05	0.024	< 10
		1-11	0.10	0.04	0.64	< 0.005	< 10
W4	Entomology Lab	2-16	< 0.05	< 0.02	< 0.05	0.021	< 10
		1-11	0.17	0.03	2.49	< 0.005	< 10
W8	Landfill 5	2-16	< 0.05	< 0.02	< 0.05	< 0.005	< 10
		1-11	0.10	0.09	0.43	< 0.005	< 10
W9	Landfill 6	2-16	< 0.05	< 0.02	< 0.05	0.014	< 10
		1-11	0.08	0.08	0.45	< 0.005	< 10
Detection Limits			0.05	0.02	0.05	0.005	10 (each parameter)

[1](sol) indicates dissolved metals.

[2]VOA indicates U.S. EPA Priority Pollutant List Volatile Organic Compounds (see Appendix D).

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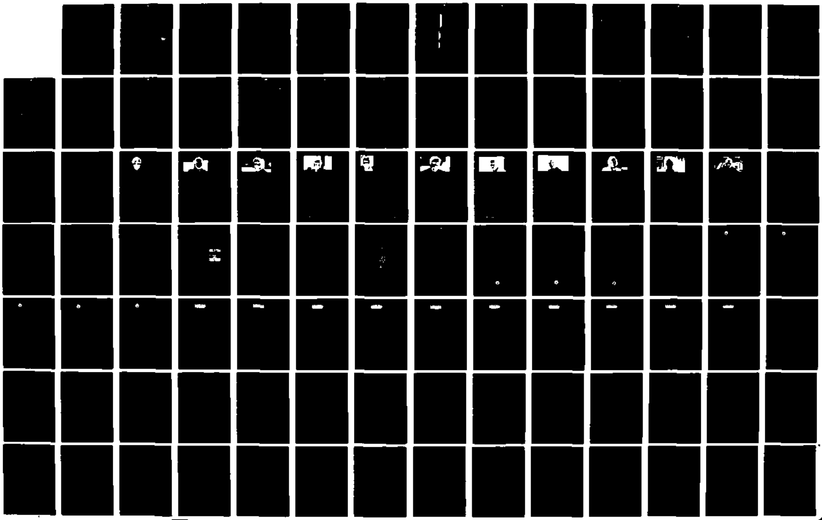
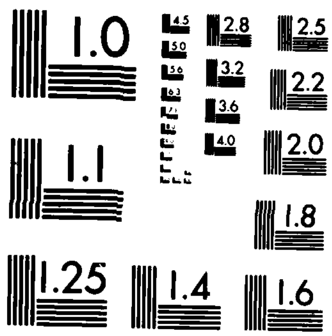




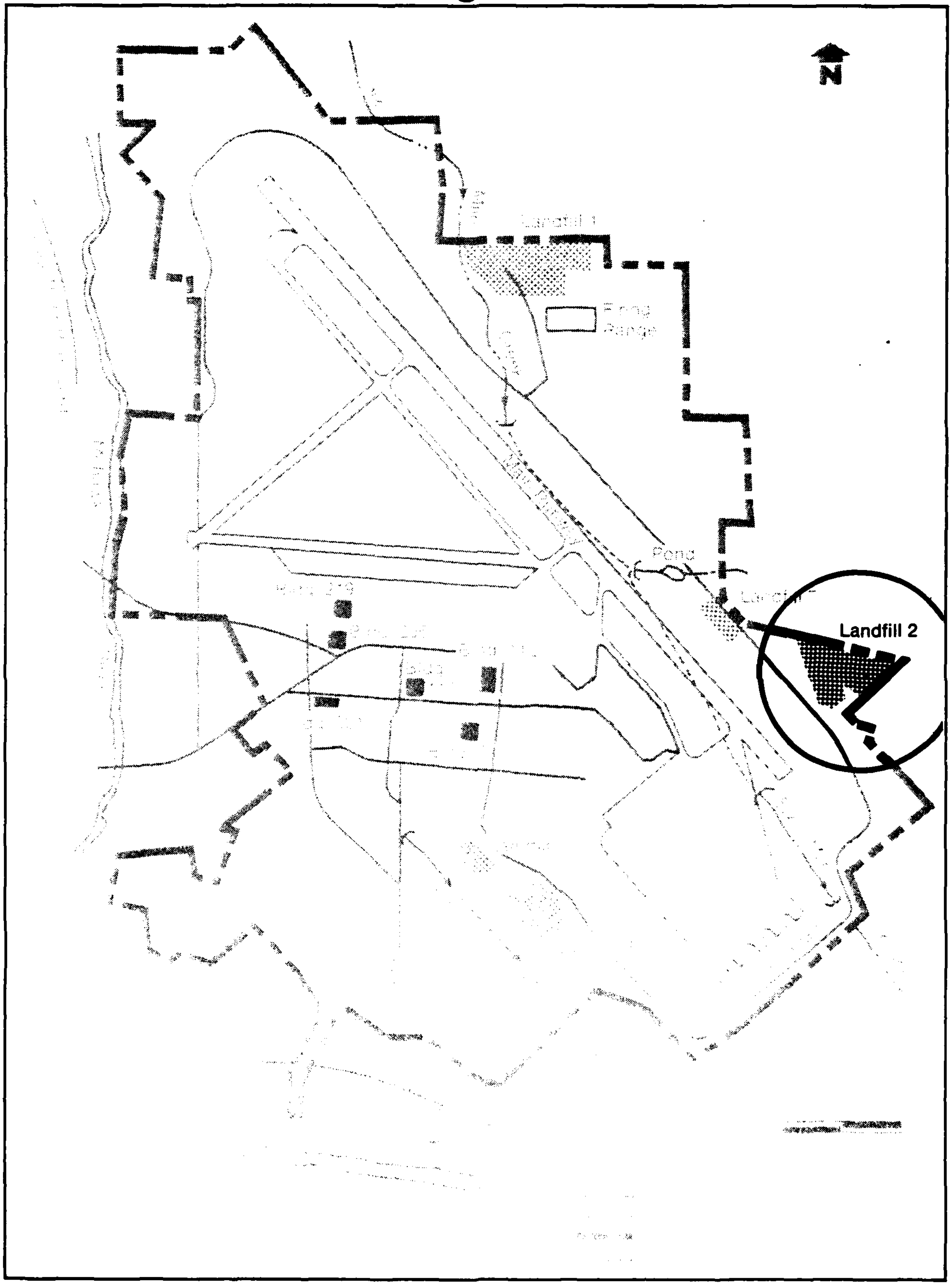


FIGURE 16 LOCATION OF LANDFILL NO. 2, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

The landfill has been partially closed by placement of a layer of coarse intermediate cover. The surface has been partially regraded to direct drainage to the southeast and southwest. The site is barren; revegetation has not yet been established and no soil cover has been emplaced. There is a scant growth of weeds on parts of the surface. Erosion gullies are present, particularly along the access road. Miscellaneous debris is scattered about the site.

Monitor Well W2 was installed adjacent to the landfill toe in a down gradient direction between the landfill and Perimeter Road. The location of Well W2 is shown on Figure 17, which is an expanded plan view of the Landfill No. 2 site configuration. Subsurface materials sampled during monitor well construction were predominantly fine- to coarse-grained sands. Bedrock was not encountered in boring W2. Groundwater quality analyses of samples from Well W2, as summarized in Tables 13 and 14, detected some potential contaminants at very low concentrations. However, it should be noted that this is the most recently active landfill at the base, and, as such, it has the highest probability of generating leachate in the near future of any of this group of sites. Recently deposited refuse is probably undergoing rapid decomposition with the landfill. Decomposition products and unrestricted infiltration of precipitation (due to the absence of a final cover) will combine to form this leachate. Therefore, the Air Force should complete closure of Landfill No. 2 in accordance with State regulations prior to the advent of major leachate generation from the filled materials.

6.3.2 Concept Engineering Analysis

Landfill No. 2 will require proper closure when use is permanently discontinued. This site was used for waste disposal as recently as 1980 and has not yet been completely closed. Methane accumulation in the nearby buildings is not expected, but remains a possibility due to the porous nature of the native soils and the absence of a liner under the landfill. Unauthorized dumping does not appear to be a current problem at Landfill No. 2. Future problems of this sort can be detected quickly with a regular inspection program.

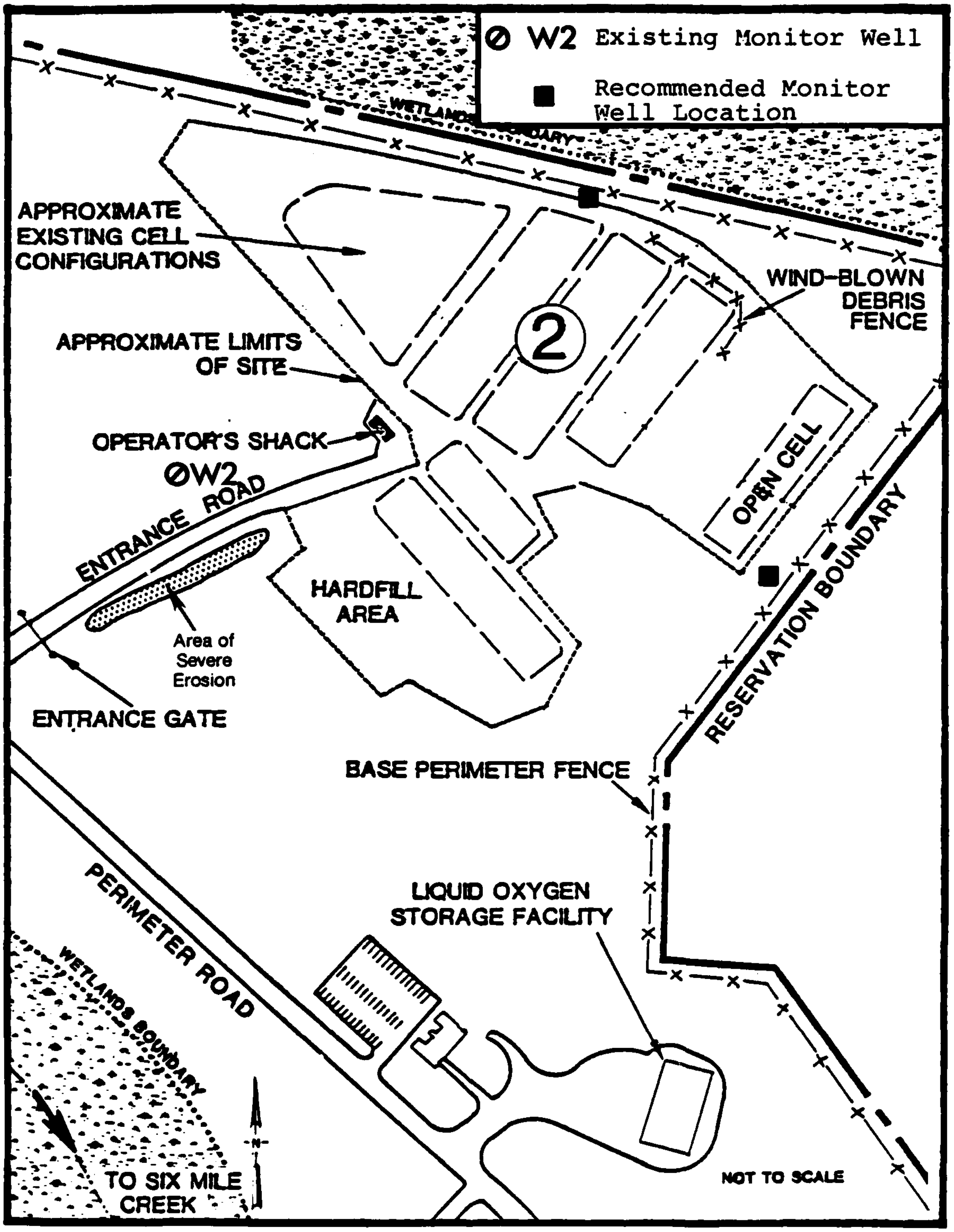


Figure 17: Expanded Plan View of Landfill No. 2, Griffiss Air Force Base, Rome, New York

The Minimal and Additional Actions for Landfill No. 2 are summarized in Table 15. Figure 18 is a schematic cross section representing the Minimal Action Options applied to existing conditions at the site. The Minimal Action described would serve to close Landfill No. 2 in accordance with New York State regulatory requirements for sanitary landfills. The regular inspection program specified in Table 15 would include:

- Examination of the cover for differential settlement and erosion damage.
- Sampling of groundwater monitoring well(s).
- Checking for possible methane accumulation in any nearby buildings.
- Checking for any evidence of unauthorized dumping.

Inspections of the site should take place semi-annually for the first two years after closure and annually thereafter. Table 11 summarizes a typical groundwater monitoring program for a closed sanitary landfill in the State of New York. A program of this type would be applicable to Landfill No. 2 at Griffiss Air Force Base. The analytes listed are those which should detect leachate emanating from a typical sanitary landfill. The groundwater and visual monitoring program should be continued for a minimum of five years. At the end of the first five years, the results should be evaluated and a decision made concerning possible future monitoring. If no contamination has been found it may be possible to discontinue the program. It may also be decided to continue the program, either as suggested above, or on a reduced scale and frequency.

6.4 LANDFILL NO. 5 AND 6

6.4.1 Site Evaluation

Landfill No. 5 and 6 are located adjacent to each other on the southeastern part of the base, to the northeast of Three Mile Creek, as shown in Figure 19. Due to their proximity and historic usage similarities, they will be discussed as a unit.

Table 15

Remedial Action Alternatives for Landfill No. 2, Griffiss Air Force Base, Rome, New York

MINIMAL ACTION OPTIONS

* Clean up wind blown or exposed wastes for proper disposal.
* Remove standing water for proper disposal prior to emplacement of a final cover.
* Rough grade, backfill and compact the landfill surface to provide positive drainage and a firm base for a final cover, and to ensure that ponding of precipitation will not occur in the future.
* Place a final cover consisting of 18 inches of compacted, low permeability soil, and 6 inches of topsoil, as required by New York State Regulations.
* Vegetate final cover, with mulch stabilization to provide protection against erosion, and enhance reduction of infiltration of precipitation by increasing evapotranspirative losses.
* Repair erosion washouts, particularly to the south of the entrance road, to preserve site integrity.
* Implement a regular inspection program.
* Install two additional groundwater monitor wells, at the locations shown on Figure 17.
* Institute a regular groundwater quality monitoring program.

ADDITIONAL ACTIONS

- If monitoring data indicate that significant leachate generation and migration is occurring, a multi-layer cover system, such as the one shown in Figure 14, could be installed to further reduce infiltration to the landfill.
- If monitoring data indicate that contaminant migration is occurring, then additional monitor wells could be installed in order to define the extent of the migration.

*Indicates those actions which are minimal in order to satisfy current closure of the site as required by New York State Regulations (see Appendix I).

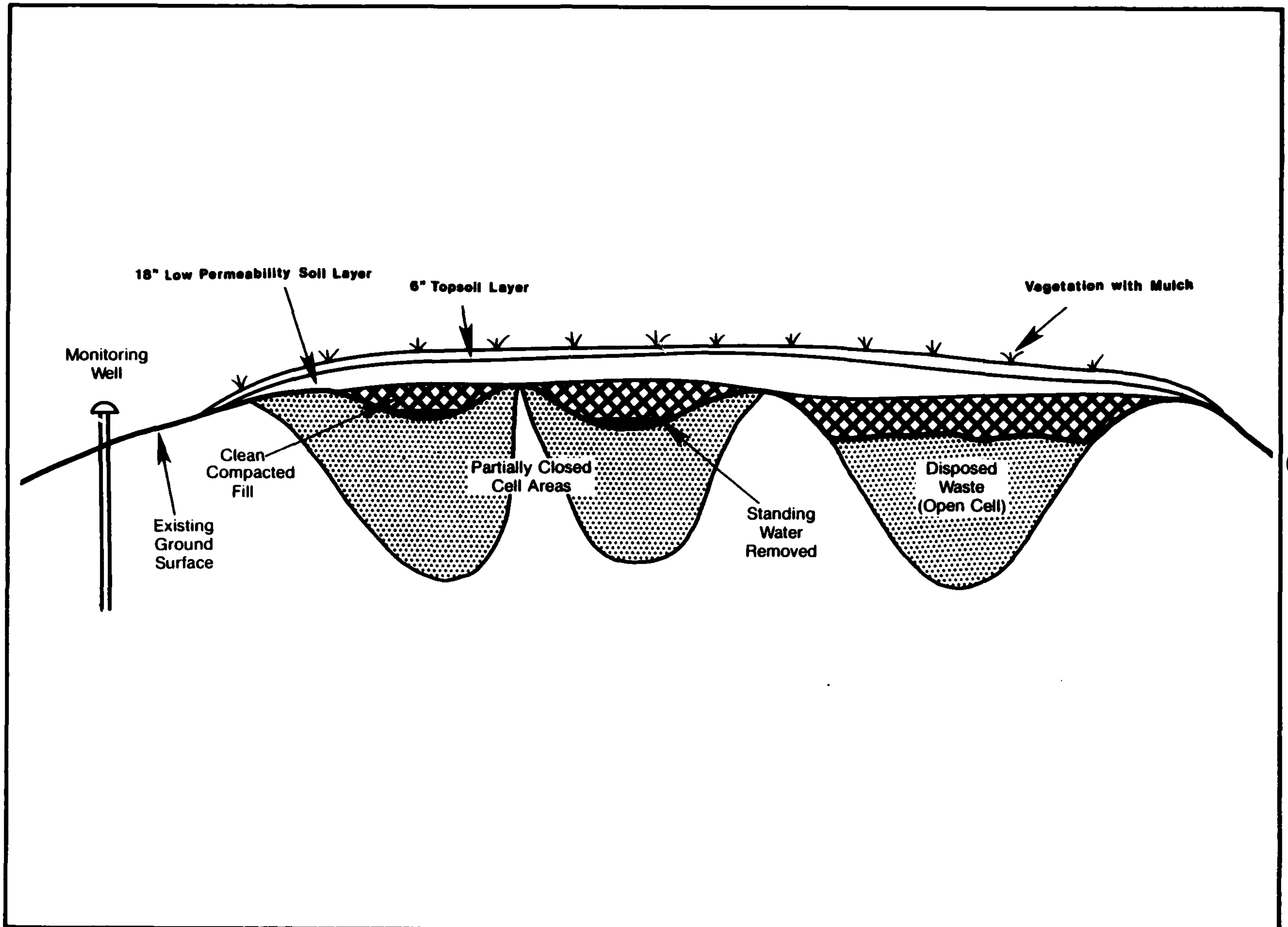


Figure 18: Typical Cross-Section of Minimal Action as Applied to Landfill No. 2, Griffiss Air Force Base, Rome, New York

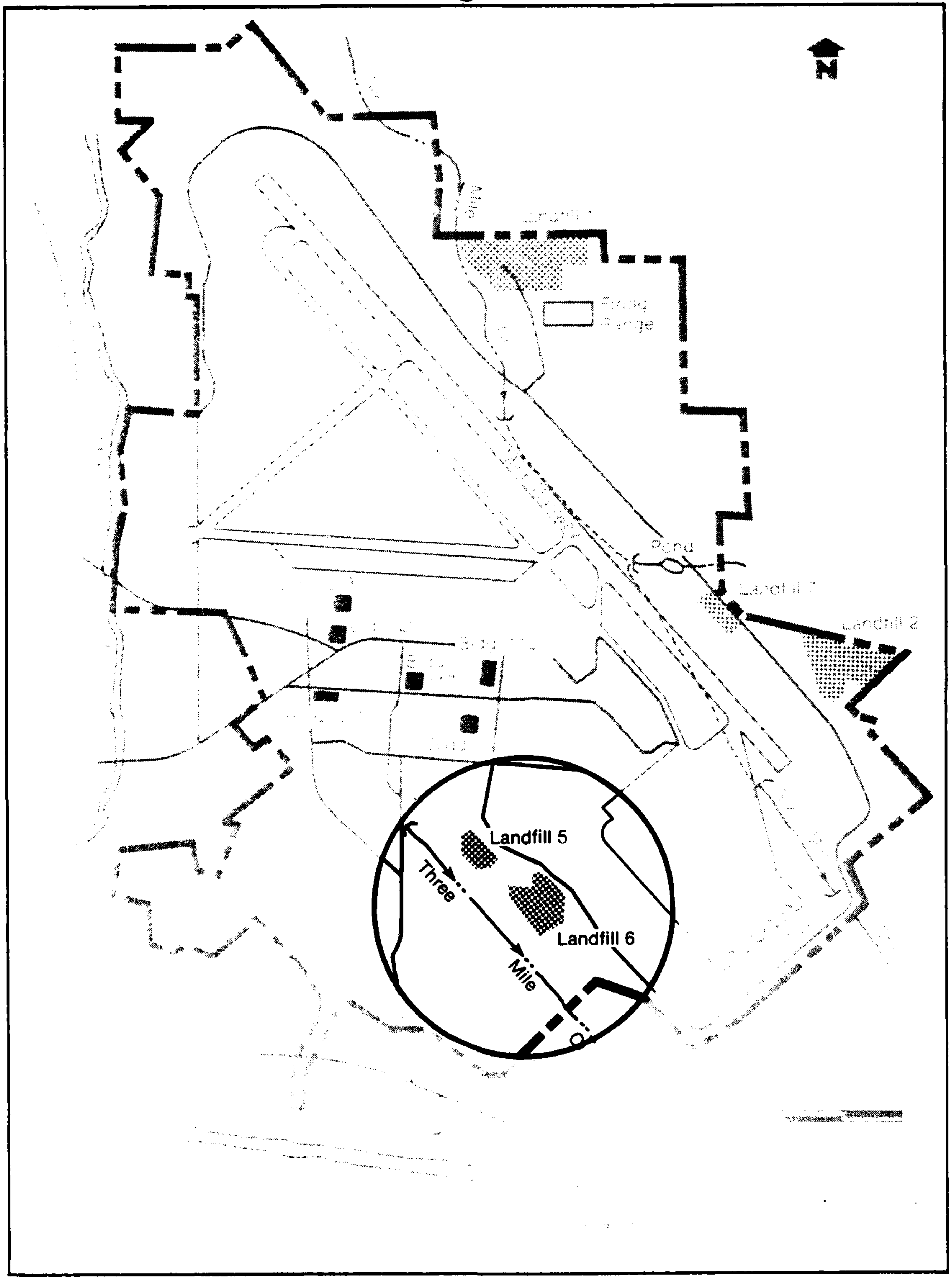


FIGURE 19 LOCATION OF LANDFILL NO. 5 AND 6, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

These landfills were operated in the late 1950's and contain municipal wastes that were burned and covered. Both landfills are built out over the flood plain of Three Mile Creek and the edges of the landfills drop off abruptly to the natural land surface approximately eight to 12 feet below the surface of the fill. Although no evidence of serious erosion was observed on these slopes, it appears that erosion may be a problem in the future, particularly in the spring of each year. The landfill surfaces are flat and overgrown with a thick brushy growth, except for the sloping area at the eastern end of Landfill No. 6 which is densely planted with mature softwoods. This revegetation has occurred in spite of a thin final soil cover material. At the time when these landfills were closed no regulations were in-place which governed and specified procedures for closure of sanitary landfills.

Monitor Well W8 was installed adjacent to the toe of Landfill No. 5 in a downgradient direction between the landfill and Three Mile Creek. Monitor Well W9 was installed in an analogous position at Landfill No. 6. The locations of both monitor wells are plotted on Figure 20, which is an expanded plan view of Landfill No. 5 and 6. Subsurface materials sampled during monitor well construction were predominantly fine-grained silty sands. Bedrock was not encountered in either boring. Groundwater quality analyses of samples from Wells W8 and W9, as summarized in Tables 13 and 14, detected no compounds at concentrations which will cause immediate environmental concern. Due to the ages of these two landfills, it appears that the probability of either of them generating significant quantities of leachate in the future is low. No further actions are recommended at Landfill No. 5 and 6.

6.5 LANDFILL NO. 7

6.5.1 Site Evaluation

Landfill No. 7 occupies approximately 4.5 acres located on the northeast side of the main runway, as shown on Figure 21. The boundaries of the site are not well defined. The landfill was active between 1950 and 1954 and contains domestic refuse type solid wastes, unknown types of liquid wastes, and miscellaneous wastes, all of which were burned in trenches. The landfill is located on a topographic high, is now completely grass covered or paved over, and is indistinguishable from adjacent areas. There is evidence that burrowing animals have removed some of the burned residues from the landfill. Other than localized depressions on the landfill surface, possibly caused by differential settlement, the site is graded to promote surface runoff in all directions. No serious erosion was observed.

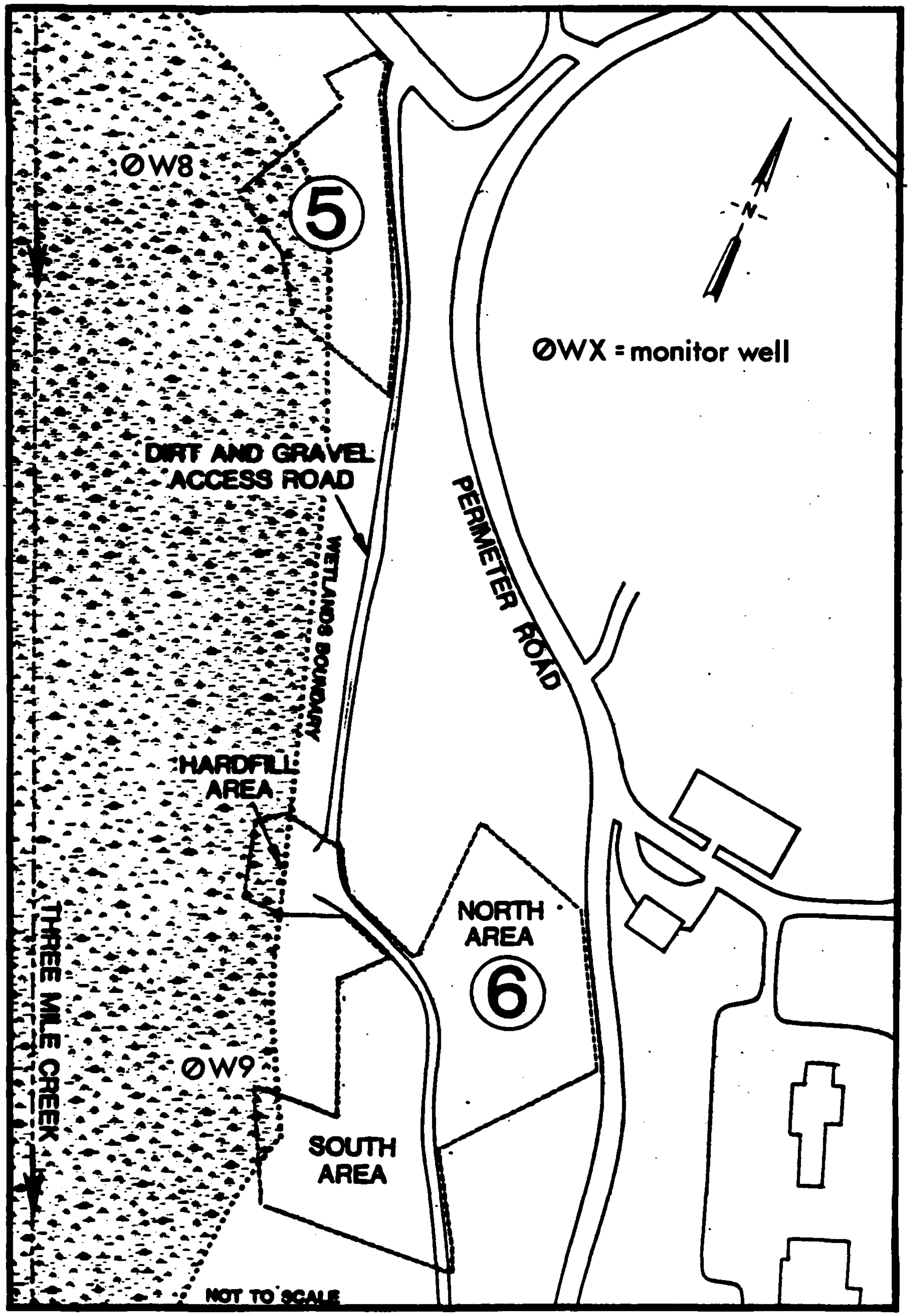


Figure 20: Expanded Plan View of Landfill No. 5 and 6, Griffiss Air Force Base, Rome, New York

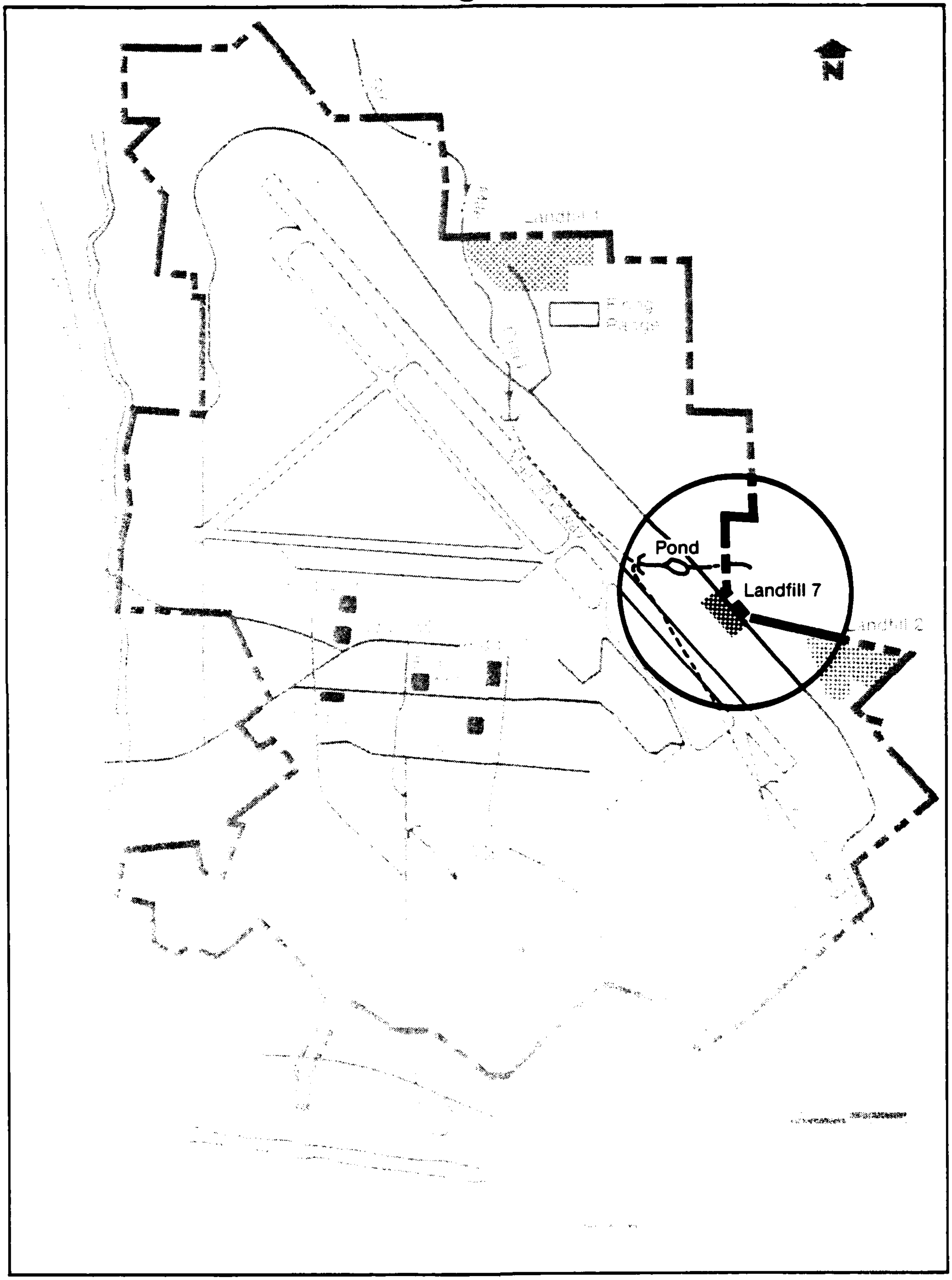


FIGURE 21 LOCATION OF LANDFILL NO. 7, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

Monitor Well W3 was installed adjacent to the toe of Landfill No. 7 in a down gradient direction between the landfill and Six Mile Creek. The location of Monitor Well W3 is shown on Figure 22, which is an expanded plan view of Landfill No. 7. Subsurface materials sampled during monitor well construction were predominantly fine- to coarse-grained sands. Bedrock was not encountered at this boring site. Groundwater quality analyses of samples from Well W3, as summarized in Tables 13 and 14, detected no compounds at concentrations which will cause immediate environmental concern. Due to the age of this landfill, the probability that significant leachate generation will occur in the future is low. No further actions are recommended at Landfill No. 7.

6.6 DRY WELL EVALUATION

6.6.1 General

WESTON interviewed Base Bioenvironmental Engineering and Civil Engineering personnel to gain some insights into the nature of the dry wells used for disposal or storage of waste chemicals in the past. Many of these dry wells are constructed as gravel filled pits three to four feet on a side and ten feet deep. Others are poured concrete tanks of roughly similar dimensions. They were used either for storage or for direct disposal of liquid chemical and chemical-related wastes in the past.

6.6.2 Site Evaluations

The locations of most of the dry wells are imprecisely known, since many of them are completely buried or paved over with parking lots. Most of the dry wells are constructed in such a way that there is no method for inspecting the tanks from the ground surface. Aerial photo coverage of the base, discussed in Section 6.2.2 of this report, was of no assistance in either locating the dry wells or in identifying leachate plumes emanating from any of them. One of the few dry wells which could be located was the one adjacent to the Entomology Laboratory (Building 301).

6.6.3 Entomology Lab (Building 301) Dry Well

The location of this facility within the main developed part of the base is shown on Figure 23. This dry well was used for an unknown number of years for the disposal of small quantities of water used for washing pesticide containers (<1 gallon per day of rinsewater) and for small quantities of off-specification pesticides (<2 gallons per year).

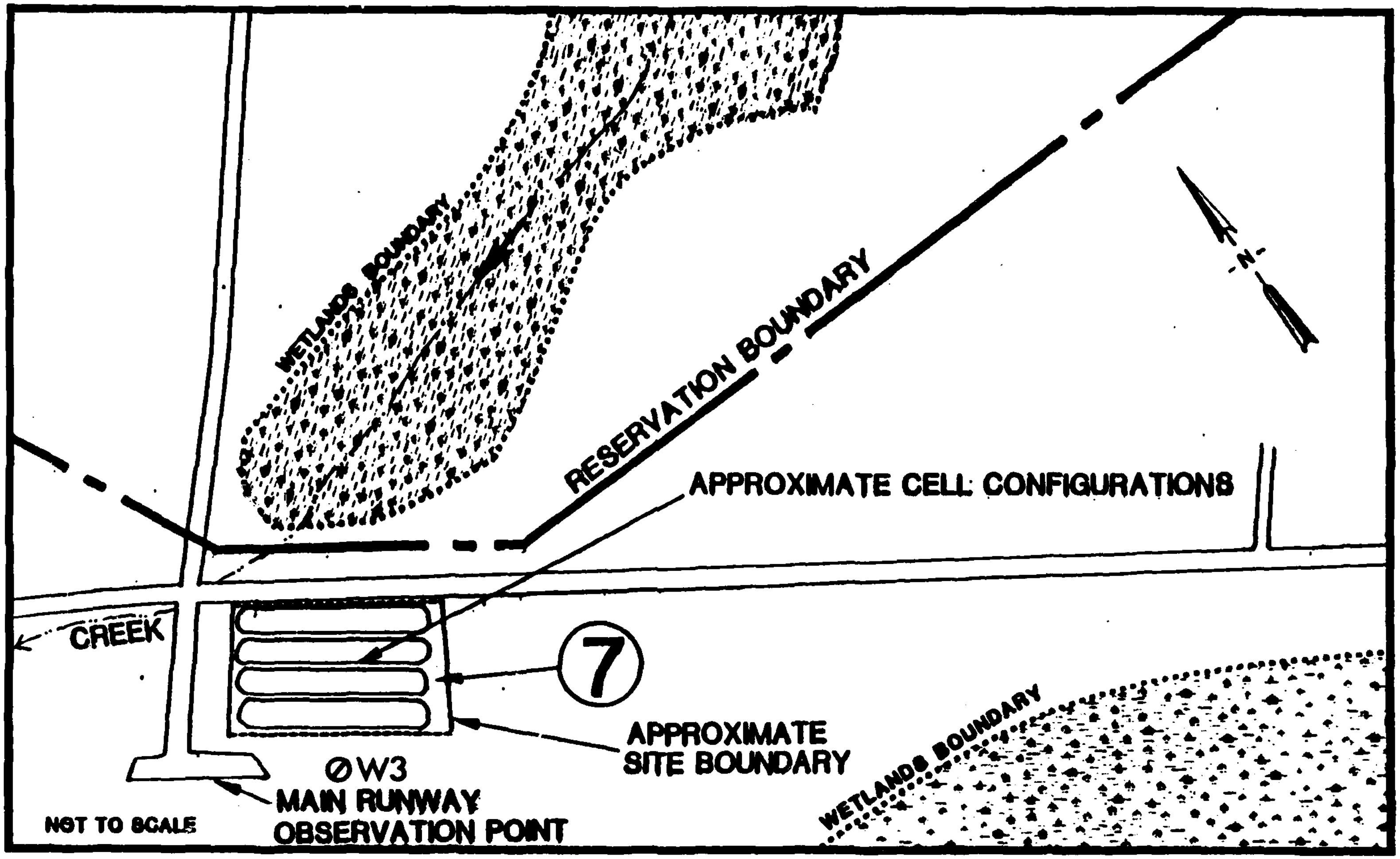


Figure 22: Expanded Plan View of Landfill No. 7,
Griffiss Air Force Base, Rome, New York

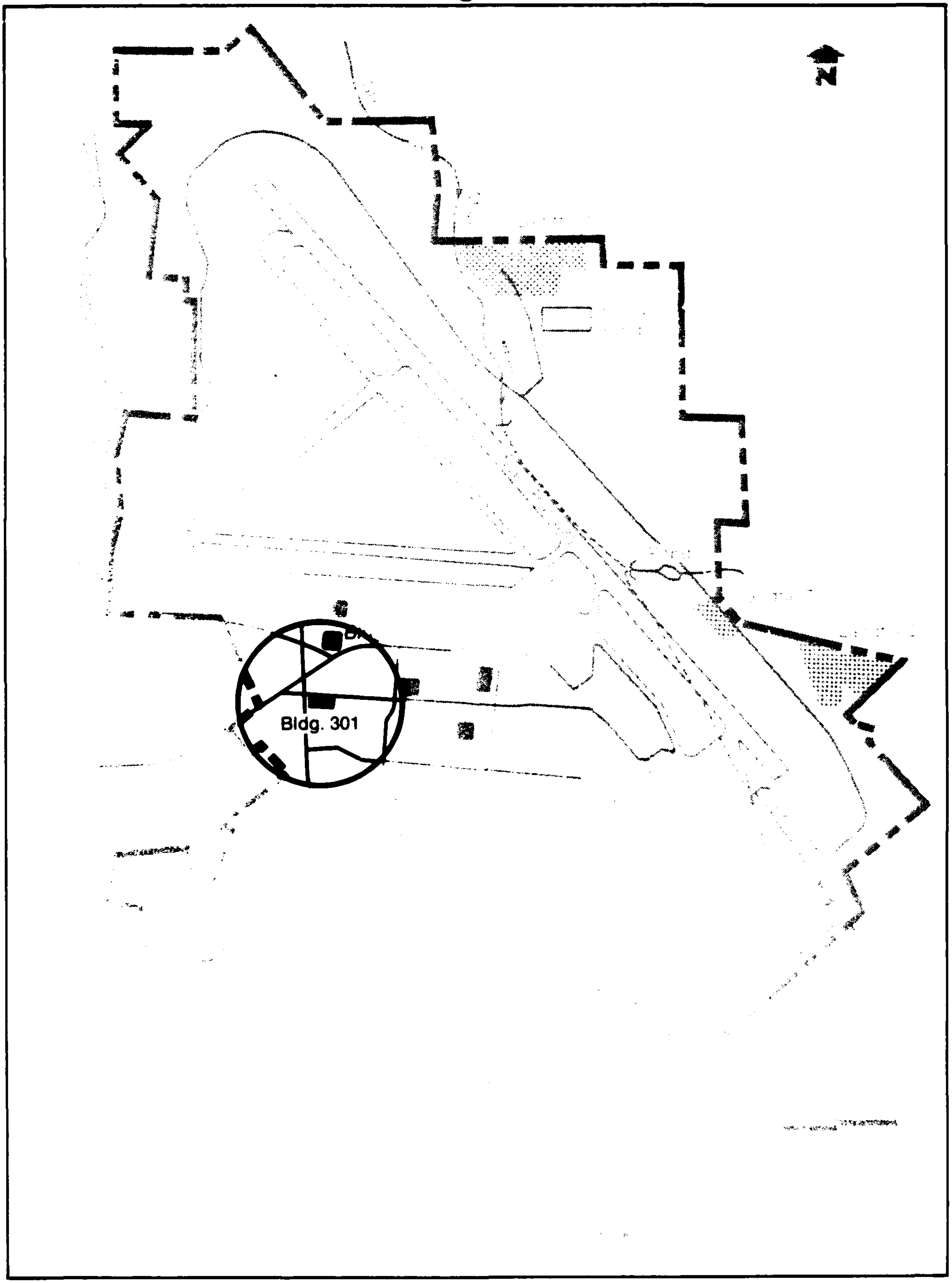


FIGURE 23 LOCATION OF ENTOMOLOGY LABORATORY, BUILDING 301, GRIFFISS AIR FORCE BASE, ROME, NEW YORK

Monitor Well W4 was installed within 50 feet of the Entomology Lab Dry Well. Topographic analysis was of no assistance in determining a downgradient direction from the dry well. This is because Building 301 lies within the central portion of the Base, which has been subjected to massive cut and fill operations in order to level out any natural relief which was present. Well W4 was installed as close to the dry well as buried utilities, parking lots, buildings and roads would allow. Subsurface materials sampled during monitor well construction were predominantly coarse gravel and sand. Bedrock was not encountered at this boring site. Groundwater quality analyses of samples from Well W4, as summarized in Tables 13 and 14, detected no pesticides.

Since no pesticides were detected in Well W4 it would appear that this dry well is of no immediate environmental concern. It is WESTON's understanding that the practice of disposing of hazardous and potentially hazardous chemicals into dry wells has been discontinued. The minimal remedial actions WESTON recommends for this dry well, and for any other chemical-receiving dry wells on the Base, are as follows:

- If any dry wells are still being used for chemical disposal, this practice should be terminated immediately.
- All drains connecting to dry wells on the Base should be identified, and either plugged, disconnected or controlled usage established.

6.7 PCB HANDLING AREA, BUILDING 112

6.7.1 General

PCB has been handled at the loading docks at Building 112, the High Power Laboratory. In the past spills are known to have occurred in this area. In addition, leakage from a transformer on the roof of Building 112 has caused contamination of roof materials. The location of Building 112 is shown on Figure 24.

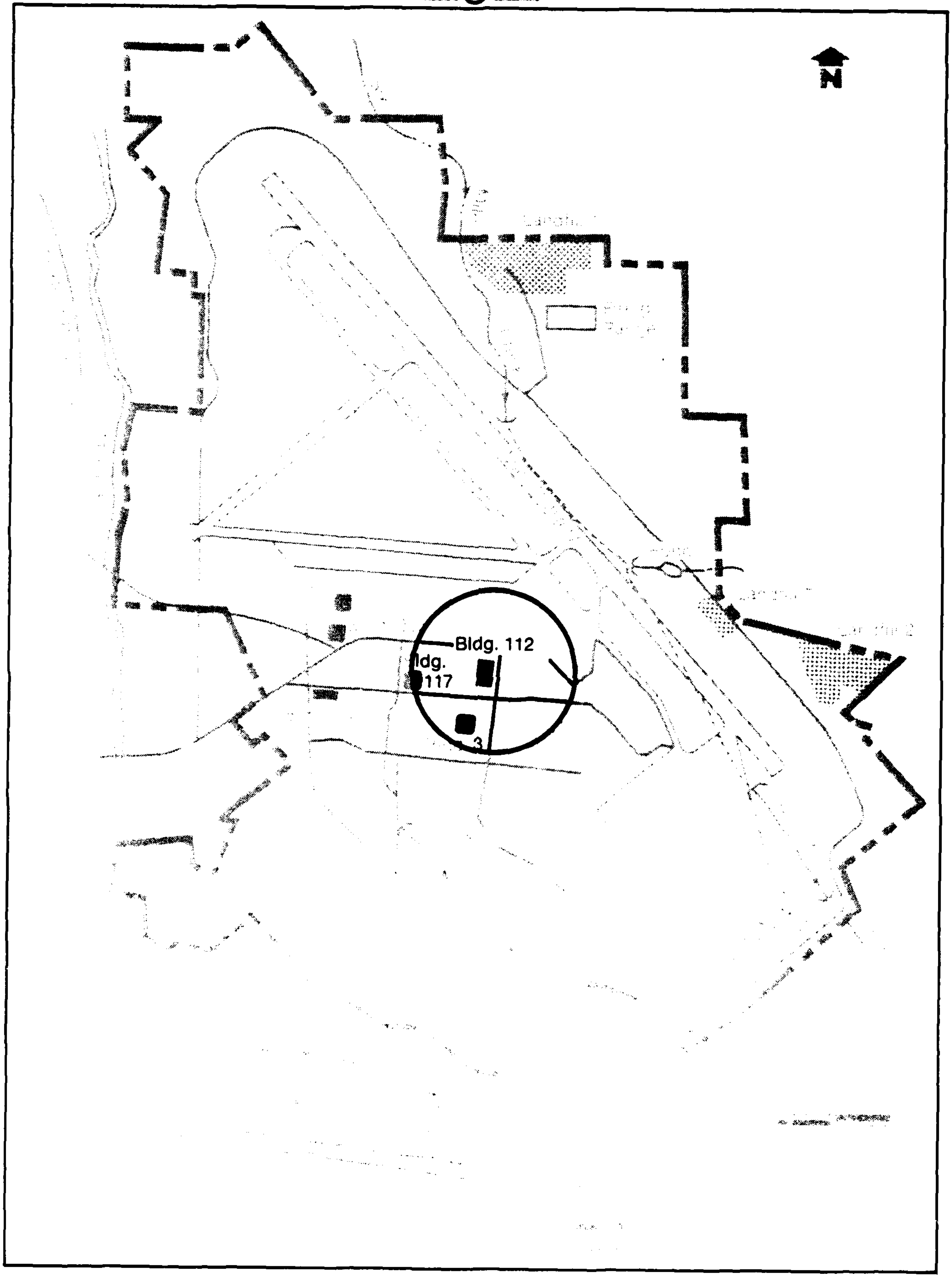


FIGURE 24 LOCATION OF PCB SPILL AREA, BUILDING 112
GRIFFISS AIR FORCE BASE, ROME, NEW YORK

WESTON

6.7.2 Investigation of PCB Spills

During July and August 1981, Base Bioenvironmental Engineers conducted a program of soil sampling and testing for PCB that included areas by the loading docks on the west side of Building 112. Sampling was done in seven locations, labelled A through G, as shown on Figure 25. PCB was found at locations D and E adjacent to the loading dock near the southwest corner of the building, in concentrations of from 5 to 530 mg/kg at depths of up to 40 inches. Table 16 presents the results obtained by the Air Force contract laboratory. WESTON's investigation was to test for PCB in other areas not already identified in the Air Force Study.

Subsurface soil sampling was done at five locations with a truck-mounted auger rig. Because of the coarse gravel in the soil, split spoon sampling was not practical, so soil samples were recovered directly from the auger. The auger was advanced one foot at a time with composite samples taken from each foot. After each sample the auger was washed with detergent and loose soil was removed from in and around the boring before advancing the auger. Surface grab samples were taken at three additional locations. All samples were logged and stored in glass bottles with foil lined caps.

Boring and grab-sampling locations are shown on Figure 25. Boring B-1 was advanced to three feet, while Borings B-2 through B-5 each were advanced to five feet. Samples from locations S-1, S-2 and S-3 are surface grab samples. The results of WESTON's analyses of these soil samples for PCB are in Table 17. Analyses were planned to be done in a step-wise schedule commencing with the shallowest sample from each site. If PCB concentrations were above the USEPA Action Level of 50 mg/kg in any sample, the next lower sample would also be analyzed. Since all concentrations of PCB in the surface samples were below the USEPA Action Level, no analyses were run on deeper samples. Analysis of the sample for Boring B-1 detected no measurable PCB, while analyses of samples from Borings B-2 through B-5 detected PCB at the lower limit of detection. Analyses of surface grab samples A, B and C detected 6.6, 9.6 and 7.0 mg/kg of PCB, respectively.

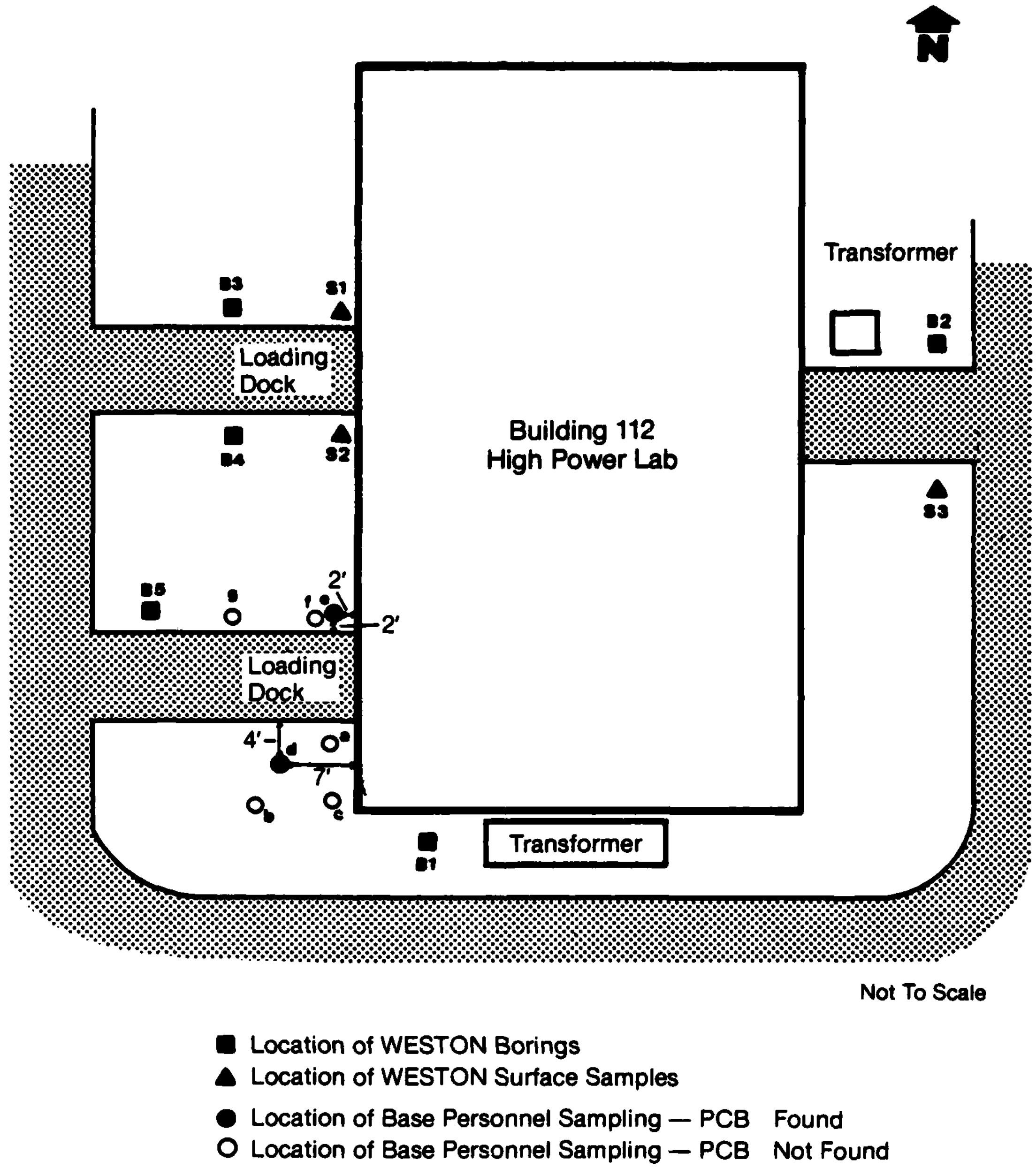


Figure 25: Locations of Soil Samples for PCB Analysis, Building 112, Griffiss Air Force Base, Rome, New York

Table 16

Historical PCB Data
Air Force Investigation, Building 112,
Griffiss Air Force Base

Depth Interval Sampled (feet)	PCB Concentration (mg/kg)**	
	Location "d"	Location "e"
0.25	125	170
0.50	86	122
1.00	78	108
1.50	63	20
2.00	39	5
2.50	30	72
3.00	50	444
3.30	26	530

*All samples were collected and analyzed by the U.S. Air Force during July and August 1981.
**Expressed as mg/kg of Aroclor 1260.

Table 17

Confirmation Stage Soil PCB Data, Building 112,
Griffiss Air Force Base

Sample Location	Depth Interval (feet)	PCB (mg/kg)*
B-1	0.0 - 1.0	<5.0
B-2	0.0 - 1.0	5.0
B-3	0.0 - 1.0	5.0
B-4	0.0 - 1.0	5.0
B-5	0.0 - 1.0	5.0
S-1	0.0 - 0.5	6.6
S-2	0.0 - 0.5	9.6
S-3	0.0 - 0.5	7.0

*All samples were collected and analyzed by WESTON during April and May 1982.
**Expressed as ppm of Aroclor 1260.

6.7.3 Remedial Action Alternatives

The remedial action alternatives for the PCB-contaminated soils at Building 112 have not been grouped as in previous remedial action sections. This is because the handling of all PCB-contaminated materials is regulated under the Toxic Substances Control Act (TSCA). The materials to be considered at Building 112 include:

- Soils contaminated with PCB in concentrations greater than 50 mg/kg.
- Roof material contaminated with PCB in concentrations greater than 50 mg/kg.

Soils contaminated with PCB in concentrations greater than 50 mg/kg must be disposed in either an Annex I (approved for PCB disposal) incinerator or in an Annex II (approved for PCB disposal) chemical waste landfill. Research is currently in progress at the Franklin Institute in Philadelphia, and at other facilities, into methods of chemical neutralization of PCB-contaminated soils; however, this technology is not yet proven on a commercial scale, and has not been approved by USEPA. It may be desirable to excavate and dispose of all PCB-contaminated soils with concentrations greater than 10 mg/kg, providing a higher level of environmental protection than excavation of only soils contaminated with concentrations greater than 50 mg/kg of PCB. The variability of PCB concentrations with depth, as shown in Table 16, may be due to past spill excavation and filling accomplished by Base personnel. Due to this variability complete excavation may be a practical necessity.

Within a 5-foot radius of locations "d" and "e" all soils should be excavated to a depth of 3.5 feet for proper disposal. This is a volume of soil of approximately five cubic yards. Soil samples should be obtained from the bottoms of the excavations and analyzed for PCB concentrations. If the concentrations obtained are below the Action Level of 50 mg/kg the excavations can be backfilled. If the data exceed the Action Level, then the excavations should be deepened and soil analyses repeated until Action Level concentrations are no longer present, then the excavations may be backfilled.

Samples were taken of potentially contaminated roofing materials and of an oil spot adjacent to the roof-mounted transformer. Results of PCB analyses of these samples are shown in Table 18. Roofing materials are contaminated with PCB in excess of the USEPA Action Level of 50 mg/kg. The leak in the transformer should be repaired, and then contaminated roof materials should be removed and replaced. Contaminated roof material must be handled in the same manner as contaminated soils, by disposal in an Annex I incinerator or an Annex II chemical waste landfill.

Table 18

Analysis of Roof and Oil Samples, Building 112, Griffiss Air Force Base

Sample Identification	PCB Concentration (ppm)
Roof Sample 1	397
Roof Sample 2	153
Grease (from front of transformer)	990,000

SECTION 7

CONCLUSIONS

A Phase II Problem Confirmation and Quantification field investigation has been conducted at Griffiss Air Force Base, Rome, New York. The investigation evaluated five landfills, one dry well and a PCB handling area. From the results of this Phase II field investigation the following conclusions may be drawn:

- Landfill No. 1 was closed in 1973 in accordance with regulations in-place at that time.
- Low level groundwater contamination was detected in the vicinity of Landfill No. 1.
- There does not appear to be any off-base migration of contaminants from Landfill No. 1.
- The leachate seep at Landfill No. 1 is the surface expression of the only "plume" of contaminants migrating off the landfill site.
- The low concentrations, limited distribution and very limited range of contaminant types in leachate from Landfill No. 1 indicate that the "plume" located southwest of the landfill represents an isolated occurrence.
- The only volatile organic compound (ethylbenzene) in the "plume" was not detected in the leachate from Landfill No. 1.
- Additional monitoring of groundwater and leachate quality at existing wells is needed in order to verify the limited magnitude and extent of the "plume" southwest of Landfill No. 1.
- No potable water supply wells occur within one-mile downgradient of Landfill No. 1.
- Leachate from Landfill No. 1 does not appear to be toxic to vegetation.

- High dilution factors render the leachate contaminants virtually undetectable at short distances downstream from Landfill No. 1 on Six Mile Creek.
- Landfill No. 1 appears to have no significant impact upon water quality in Six Mile Creek at the point where the creek leaves the base.
- Two remedial actions are appropriate for Landfill No. 1, as a minimum, including: 1) cleanup and proper disposal of all exposed wastes, and 2) backfill surface depressions, compact and regrade the surface to provide positive drainage.
- Additional remedial actions may be appropriate for Landfill No. 1 based upon the results of continued water quality monitoring.
- Ground Penetrating Radar (GPR) is effective for identifying boundaries of landfills.
- No leachate migration was detected at Landfill No. 2, although two additional monitor wells will be needed to verify this and to satisfy closure requirements of the State of New York.
- Since Landfill No. 2 was the waste disposal site in most recent use at Griffiss Air Force Base, it has the highest probability of producing new leachate in the future.
- Upon termination of all waste disposal at Landfill No. 2, the site will require closure in accordance with regulations of the New York Department of Environmental Conservation.
- No leachate migration was detected at Lnadfill No. 5, 6 or 7. Due to their ages, these landfills are not expected to generate leachate in the future.
- No additional work or remedial actions are appropriate at Landfill No. 5, 6 or 7.
- No pesticides were detected in groundwater near the Entomology Laboratory, Building 301.

- Generic remedial actions are appropriate to all dry wells, including: 1) cessation of waste disposal in dry wells, and 2) all drains leading to dry wells should be either plugged, disconnected or have controlled usage established.

- PCB soil contamination in the vicinity of the High Power Laboratory, Building 112, appears to be limited to Areas "d" and "e" of the Air Force sampling program.

- Roof materials at Building 112 are contaminated with PCB from a leaking transformer.

- Remedial actions are appropriate at Building 112, including: 1) removal of roof materials and soils contaminated with PCB at higher concentrations than the action level of 50 mg/kg, and 2) disposal of these materials in either an Annex I incinerator or an Annex II chemical waste landfill.

- None of the former waste disposal sites at Griffiss Air Force Base which were evaluated under this Phase II Problem Confirmation and Quantification field investigation should be of major environmental concern.

SECTION 8

RECOMMENDATIONS

A number of conclusions have been drawn from the results of the Phase II Problem Confirmation and Quantification field investigation at Griffiss Air Force Base. Several actions are appropriate in order to address the implications of these conclusions, including:

- Additional groundwater quality monitoring should be done on existing wells in the vicinity of Landfill No. 1 to verify the limited nature and distribution of leachate from that site. As a minimum, monitor wells W1, W5, W7 and P2 should be included in this program.

- In order to comply with closure requirements of New York State, the minimal action options of 1) cleanup of all exposed wastes, and 2) backfilling of surface depressions, compacting and regrading, should be implemented at Landfill No. 1.

- Additional actions for Landfill No. 1, such as installation of a clay and topsoil cover over non-reforested areas, and revegetation of this cover, should be considered pending results of the additional groundwater quality monitoring recommended above.

- Two additional monitor wells should be constructed at Landfill No. 2 for compliance with state closure requirements.

- All waste disposal at Landfill No. 2 should be terminated as soon as alternative disposal arrangements can be made.

- Upon termination of all waste disposal activities at Landfill No. 2, the site should be closed in accordance with regulations of the New York State Department of Environmental Conservation.

- No further actions are recommended for Landfill No. 5, 6, or 7.

* Use of dry wells as a waste disposal mechanism should be discontinued. Drains leading to dry wells should be either disconnected, plugged or have a controlled usage established.

* The leaking transformer at Building 112 should be repaired as soon as possible.

* As soon as possible after repair of the leaking transformer, soils and roof materials at Building 112 having PCB concentrations in excess of the 50 mg/kg action level should be removed for proper disposal in either an Annex I incinerator or an Annex II chemical waste landfill.

APPENDIX A

PROFESSIONAL PROFILES OF PROJECT TEAM MEMBERS

Peter J. Marks

Fields of Competence

Project management; environmental analytical laboratory analysis; source emissions/ambient air sampling; wastewater treatment; biological monitoring methods; and environmental engineering.

Experience Summary

Fourteen years in Environmental Laboratory and Environmental Engineering as Project Scientist, Project Engineer, Process Development Supervisor, and Manager of Environmental Laboratory with Weston. Experience in analytical laboratory, wastewater surveys, stream surveys, process development studies, and source emission and ambient air testing. In-depth experience in pulp and paper, steel, organic chemicals, pharmaceutical, glass, petroleum, petrochemical, metal plating, and food industries.

Applied research on a number of advanced wastewater treatment projects funded by Federal EPA.

Credentials

B.S. Biology — Franklin and Marshall College (1963)

M.S. Environmental Engineering and Science — Drexel University (1965)

American Society for Testing and Materials

Water Pollution Control Federation

Water Pollution Control Association of Pennsylvania

Employment History

1965-Present	WESTON
1963-1964	Lancaster County General Hospital Research laboratory for analytical methods development

Key Projects

EPA, Durham, North Carolina. This three-year BOA contract (October 1977 to October 1980) is to conduct stationary source emission testing for the Emissions Measurements Branch. Primary work involves data collection for establishment of new source performance standards. The estimated contract size is 4,000 man hours/year. Seven work assignments have been completed or are in progress.—Project Manager.

Confidential Client, Ohio. WESTON has a continuing corporate contract to conduct source testing, wastewater, and solid waste surveys at eight plant sites. Primary emphasis to date has been emission testing. The annual average contract size is 3,000 man hours/year.—Project Manager.

Confidential Client, Ohio. WESTON has an on-going corporate contract to conduct corporate emission testing and special projects, at 46 United States and three overseas plants. WESTON must be able to assign up to four professionals with only a 1- to 2-week notice. The annual average contract size is 5,000 man hours.—Project Manager.

Confidential Client (Inorganic and Organic Chemicals). This is a current contract to conduct wastewater sampling and analysis of plant effluent for priority pollutants. The project also includes a wastewater treatability study to evaluate a number of process alternatives for removal of priority pollutants from the present effluent. The contract size is 5,000 man hours.—Project Manager.

Confidential Client, Provo, Utah. In-depth wastewater survey, in-plant study, treatability study, and concept engineering study in support of the clients' objectives to meet 1983 effluent limitations. WESTON had two project engineers, two chemists, five technicians and an operating laboratory in the field. Field effort is six months duration; contract size is 13,000 man hours.—Technical Project Manager.

In conjunction with University of Delaware, WESTON analyzed more than 500 biological and marine sediment samples for eleven constituent trace metals as part of a program to identify and trace the migration of metals from ocean dumping of sludges on the continental shelf off the coast of the State of Delaware.—Technical Project Manager.

WESTON laboratories conducted a wastewater analysis and biological treatability project for industrial client for the identification and degradation of six pesticide-containing wastewaters.—Project Manager.

EPA/NERC, Cincinnati, Ohio research project to develop a synthetic suspended solid sample for use in EPA's Quality Assurance Program—Project Manager.

Publications

"Microbiological Inhibition Testing Procedure," Biological Methods for the Assessment of Water Quality, A.S.T.M. Publication STP 528.

"Heat Treatment of Waste Activated Sludge" (with V.T. Stack).

"Biological Monitoring in Activated Sludge Treatment Process," a joint paper with Stover/M. Woldman.

Professional Profile

Frederick Bopp III, Ph.D.

Fields of Competence

Groundwater resources evaluation; hydrogeologic evaluation of sanitary landfills and other waste disposal methods; detection and abatement of groundwater pollution; digital modelling of groundwater flow and solute transport; statistical analysis of geological and geochemical data; geochemical prospecting; estuarine geology and geochemistry; trace metal and aqueous geochemistry.

Experience Summary

Four years of experience in hydrogeology and geochemistry, involving such activities as: quantitative chemical analysis of water and soil; ore assay and ore body evaluation; drilling supervisor; hydrogeologic assessment; pollution detection and abatement; estuarine pollution analysis; application of flow and solute transport computer models; computer programming; project management; teaching environmental geology and geochemistry.

Credentials

B.A. Geology — Brown University (1966)

M.S. Geology — University of Delaware (1973)
Thesis: "Trace Metals Near Shell Banks in Delaware Bay"

Ph.D. Geology — University of Delaware (1979)
Thesis: "Trace Metal Geochemistry of Upper Delaware Bay"

Affiliations

Sigma Xi, The Scientific Research Society of North America

Geological Society of America: Hydrology Division

National Water Well Association: Technical Division

American Association for the Advancement of Science

Society for Environmental Geochemistry and Health

Estuarine Research Federation: Atlantic Estuarine Research Society

Employment History

1979-Present	Weston
1977-1979	U.S. Army Corps of Engineers Waterways Experiment Station Staff Hydrogeologist
1976-1977	University of South Florida Department of Geology Visiting Assistant Professor of Geochemistry
1970-1976	University of Delaware Department of Geology Research and University Fellow
1974-1976	Earth Quest Associates President and Principal Partner
1974 Summer	Weston
1966-1970	United States Navy Commissioned Officer

Key Projects

Flow and solute transport digital model of a heavily-pumped aquifer in southern New Jersey.

Definition and abatement of groundwater contamination from chemical manufacture in the Denver area.

Flow and solute transport digital model of a contaminated groundwater aquifer in the Denver area.

Hydrogeologic impact assessment of on-land dredge spoil disposal in coastal North Carolina.

Hydrogeologic and estuarine impact assessment of phosphoric acid manufacture in the Tampa area.

Geochemical prospecting and ore body analysis in Arizona.

Definition and abatement of groundwater contamination from a hazardous waste site in northern New England.

Definition and abatement of groundwater contamination from plating and foundry wastes in eastern Pennsylvania.

Operational test and evaluation of new naval mine ordnance in southern Florida.

Publications

Optimum Future Demand Analysis: Final Report on Substudies V and VI, Southern New Jersey Water Resources Study; USAE-WES, Vicksburg, MS, 76 p., 1979.

The Remobilization of Trace Metals from Suspended Sediments Entering the Delaware Estuary: presented at the 27th Annual Meeting, Southeastern Section, Geol. Soc. America, Chattanooga, TN, April 1978.

Professional Profile

Richard C. Johnson

Fields of Competence

Hydrologic and geologic investigations of waste disposal sites; engineering properties of soil and rock; laboratory determination of mechanical properties of soils; laboratory investigation of physical properties of sulfite sludges and coal burning wastes; hydrogeological analysis of limestone karst terrains; optical and x-ray diffraction analysis of geological materials.

Experience Summary

Three years experience in geotechnical and engineering geology, including hydrologic and geological investigation of landfill sites, industrial waste disposal assessment, evaluation of soil mass stability and bearing capacity at proposed sites of building and tank structures; development of remedial actions for sinkhole collapse around structures in limestone terrains; supervision of engineering of laboratory programs for soil and waste material testing.

Credentials

B.S.—LaSalle College (1969)

M.A. Geology—Temple University (1976)

Graduate course work in soil mechanics, engineering geology and hydrology—Drexel University (1979-1981)

Geological Society of America, Engineering Geology Division

U.S. National Group of Engineering Geology

Philadelphia Geologic Society

Employment History

1981-Present	WESTON
1979-1981	Valley Forge Laboratories Devon, Pennsylvania Engineering Geologist Supervisor, Soils and Materials Testing Laboratory
1978-1979	Ambric Engineering Philadelphia, Pennsylvania Field Geologist
1976-1977	American Cancer Society Philadelphia, Pennsylvania Director of Development and Education
1972-1975	Temple University Department of Geology Teaching and Research Assistant
1969-1971	City of Philadelphia Department of Licenses and Inspections Housing and Fire Inspector

Key Projects

Supervision of investigations in New Jersey and Pennsylvania to determine subsurface conditions at proposed waste disposal sites. Studies included developing geologic profiles of the sites, locating groundwater, and determining the engineering properties of undisturbed and remolded soils samples.

Project Manager and Principal Investigator for a subsurface investigation to determine soil conditions at the proposed site of 55,000 barrel fuel storage tanks in a flood plain area in northeast Pennsylvania. Supervised soil borings and performed analyses to predict settlement probabilities for flexible pad foundations.

Investigated geologic and hydrologic conditions in an expanding suburban area in southeastern Pennsylvania to determine past and future impacts of on-site sanitary systems.

Supervised exploratory drilling and developed foundation recommendations for proposed building construction projects in southeastern Pennsylvania.

Conducted site investigations in limestone sinkhole areas to develop recommendations for remedial action around threatened structures.

Developed and directed a testing program to evaluate preliminary rock anchor designs in a sewage facility construction project, Montgomery County, Pennsylvania.

Supervised laboratory testing program for sulfite sludges and coal burning wastes. Evaluated alternative methods of physical and chemical stabilization of the wastes, and developed applications for stabilized material in landfill, and earth stabilization problems

Professional Profile

Michael H. Corbin,P.E.

Registration

Registered Professional Engineer in the Commonwealth of Virginia

Fields of Competence

Solid waste and hazardous waste management including disposal, collection, storage, transfer, shredding, and resource recovery; industrial waste disposal and sludge management; disposal facility design and permiting.

Experience Summary

Eight years of diversified engineering and operational experience in the field of solid waste management including interaction with regulatory agencies, optimization of industrial waste systems, handling of hazardous wastes, and disposal-site evaluation.

Credentials

B.S. Mechanical Engineering — University of Virginia (1970)

M.S. Mechanical Engineering — Massachusetts Institute of Technology (1972)

Tau Beta Pi

Sigma Xi

Employment History

1976-Present	Weston
1972-1976	County of Fairfax, Virginia Engineer
1970-1972	Massachusetts Institute of Technology Research Assistant

Key Projects

Served as Project Engineer for the following Weston solid-waste management projects:

- Development of a plant-wide solid waste management system and design for upgrading an existing on-site landfill for a major iron and steel production facility in Pennsylvania.
- Design of a secure land disposal facility and development of a waste handling program for a New Jersey metals processor.
- Preparation of the Hazardous Waste Management Plan for the State of Alabama.
- Optimization of an industrial waste handling and disposal system for a major West Virginia chemical firm.
- Design of a secure land disposal facility for a major New Jersey hazardous waste processor.
- Preparation of an industrial and hazardous waste management plan for a major Texas chemical firm.
- Evaluation of the suitability for land disposal of process sludges generated by a Pennsylvania chemical/pharmecutical firm.
- Evaluation of refuse collection alternatives for a PUD community in New Jersey.
- Preparation of a 208 Residuals Plan for Erie/Niagara Counties, New York.

As Deputy Director of the Division of Solid Waste for the County of Fairfax, Virginia, was responsible for the collection and disposal of all solid waste generated in the County (population 550,000), including the operation of a 1,500-ton/day sanitary landfill and a 40-vehicle collection fleet. Also participated in the planning, implementation, and administration of a regional solid waste disposal and resource recovery complex.

As an Engineer in the Wastewater Treatment Division for the County of Fairfax, was responsible for the operation of nine sewage treatment plants, including sludge handling and disposal systems.

As a Research Assistant, at MIT co-supervised the development and construction of a Vortex Classifier designed to sort shredded municipal refuse for recycling.

Publications/Technical Papers

"Industrial Solid Waste Containment: Upgrading Existing Landfills," by M H Corbin and W H Porter

"Management Aspects of Potentially Hazardous and Special Wastes," by M H Corbin, A A Metry, and K M Peil

"Multi-Media Environmental Impacts of Residual Waste Management," by A A Metry, M H Corbin, B Tencer, and K E Patterson

Professional Profile

Walter M. Leis, P.G.

Registration

Registered Professional Geologist in the state of Georgia (No. 440)

Fields of Competence

Detection and abatement of groundwater pollution; design of artificial recharge wells; deep well disposal; simulation of groundwater systems; hydrogeologic evaluation of sanitary landfills and other means of waste disposal; practical applications of seismic, geophysical surveys to hydrologic systems, borehole geophysical surveys. Geochemical studies of acid mine drainage and hazardous wastes.

Experience Summary

Thirteen years experience as field hydrogeologist, field supervisor, project director, research director. Six years research involving two consecutive projects: 1) application of geophysical techniques in evaluating groundwater supplies in fractured rock terrain in Delaware and Pennsylvania; 2) project director for an artificial recharge and deep well disposal study. Provided consultation for waste disposal and aquifer quality problems for coastal communities.

Developed geochemical sampling techniques for deep mine sampling. Evaluated synthetic and field hydrologic data for deep formational analysis in coal field projects.

Earlier research experience involved developing techniques for mapping subsurface regional structures having interstate hydrologic significance, and defining ore bodies by geochemical prospecting.

Credentials

B.S. Biochemistry—Albright College (1966)

M.S. Hydrogeology—University of Delaware (1975)

Cooperative Program Environmental Engineering—University of Pennsylvania

Additional special course work in Geology & Hydrology, Franklin & Marshall College and Pennsylvania State University

OWRR Research Fellow, 1973

Affiliations

National Water Well Association - Technical Division

Geological Society of America - Engineering Geological Division.

Employment History

1974-Present	Weston
1973-1974	University of Delaware Water Resources Center Research Hydrologist
1971-1973	University of Delaware Research Fellow
1967-1971	Pennsylvania Department of Environmental Resources Environmental Specialist

Key Projects

Definition of groundwater contamination from sanitary landfill leachate and recovery of contaminants to protect heavily used aquifer in Delaware.

Field design studies for artificial recharge and waste disposal wells.

Design and evaluation of hydrologic isolation systems for various class hazardous wastes.

Design and supervision of chemical and physical rehabilitation of groundwater collection systems in fractured rock and coastal plain areas.

Principal investigator for six projects involving subsurface migration of PCB's in New York, New Jersey, Pennsylvania, and Oklahoma.

Design and construction supervision of hydrocarbon recovery wells in Pennsylvania.

Geochemical evaluation of coal mine pools in West Virginia.

Geochemistry of subsurface migration of toxic substances.

Principal investigator for three projects involving migration of PCB's in a subsurface environment.

Mineable reserve evaluations for coal, sand and gravel, limestone, and clay deposits.

Geologic coordinator for reclamation and mining guidance under SMCRA and state mining regulations.

Professional Profile

James S. Smith, Ph.D.

Fields of Competence

Analytical laboratory management; organic chemistry; mass spectrometry, GC/MS/DS, high and low resolution, chemical ionization and special techniques; gas chromatography including capillary column techniques; high performance liquid chromatography (HPLC); the uses of NMR, IR, UV, visible, inorganic analyses, electrochemical, thermal techniques and surface methodologies (SEM, ESCA, SIMS) to solve industrial problems; the development of quality control measures in analytical protocols; the testing of laboratory safety methodologies; innovation of new analytical techniques and methods to solve industrial, product liability, production and environmental problems.

Experience

Eleven years experience in the supervision of an analytical group involved in solving all types of industrial problems including environmental, product safety, production, research and development. The main emphasis was on the innovative development of analytical methods utilizing instrumental technologies. In-depth experience in the organic chemicals, inorganic chemicals polymer, fiber, tire, solvent, fluorine chemicals, coke and coal tar industries. Numerous scientific presentations. Contributor to three Chemical Manufacturers Association Task Groups: Environmental Monitoring, Groundwater, and Hazardous Waste Response Center.

Taught general chemistry, analytical chemistry, organic chemistry, and instrumental analysis for four years at Eastern Michigan University and the University of Illinois.

Credentials

B.A. Chemistry - Williams College (1960)

Ph.D. Organic Chemistry - Iowa State University (1964)

Postdoctoral Organic Chemistry - University of Illinois (1966)

Postdoctoral Mass Spectroscopy - Cornell University (1969)

American Chemical Society

American Society for Testing Materials

American Society of Mass Spectroscopists

Employment History

1981 - Present	WESTON
1969 - 1981	Allied Chemical Corporation Corporate Research Center Supervisor
1966 - 1968	Eastern Michigan University Assistant Professor of Chemistry
1965 - 1966	University of Illinois Visiting Lecturer in Chemistry

Key Projects

Directed analytical group for five years of intensive sampling and analysis of a toxic insecticide. Analyses involved soil, air, water, sludge, blood, bile, feces, urine, animal feed, and plant samples to detect the compound at the low parts-per-billion level. The project involved rapid development of new and accurate analytical methods.

Developed an industrumental analytical laboratory consisting of trace environmental analyses, gas chromatography, high performance liquid chromatography, mass spectrometry, surface analyses, X-ray photoelectron spectroscopy and nuclear magnetic resonance spectroscopy including the design and manufacture of instrument modifications, purchasing instruments, and hiring of key personnel.

Isolated, identified, and developed a method of analysis for a colored impurity on a bulk chemical product. Synthesized the colorant for proof of identification and as a standard for future analysis. Proved the mechanism of the development of the color from the packaging material. Designed new specifications eliminating the problem.

Conducted corporate plant environmental laboratory QA QC audits including the development of a corporate QA QC manual.

Provided an inexpensive and accurate method of analysis of lead for a manufacturing plant effluent. A published methodology in kit form was modified for plant personnel use to measure soluble and total lead in a waste stream without use of excessive manpower or capital. QA QC procedures were included as well as the use of performance samples.

Supervision of analytical technological advances that lead to either patents and new products in the fields of coal tar chemicals, food packaging and transformer manufacturing.

Professional Profile

Amir A. Metry
Ph.D., P.E.

Registration

Registered Professional Engineer in the States of Pennsylvania and Maryland.

Fields of Competence

Engineering management; project management; water and wastewater facilities design; hazardous/solid waste management; coal residuals management; air pollution control studies and system design; environmental assessment and resources management; environmental modeling and simulation.

Experience Summary

Eighteen years experience in various environmental fields as project manager, project engineer, research associate, department manager, and principal with national and international engineering firms.

Conceptual design of stabilization facilities and land disposal facilities for chemical, waste management, and utility industries. Manager of studies involving 208 planning; environmental assessment; solid waste management plans for municipal governments; air pollution studies and system designs; stack sampling and odor control for petroleum, glass, chemical, and food industries; development of hazardous/solid waste management plans; design and construction management for water and wastewater treatment facilities for industry, government, and international firms and governments.

Credentials

B.S. Mechanical Engineering—Cairo University (1963)

M.S. Engineering Management—Cairo University (1967)

M.S. Environmental Engineering—Drexel University (1969)

Ph.D. Environmental Engineering—Drexel University (1972)

American Society of Civil Engineers

National Society of Professional Engineers

Water Pollution Control Federation

Water Pollution Control Association of Pennsylvania

Institute of Environmental Sciences

Diplomate of the American Academy of Environmental Engineers

Employment History

1981-Present	WESTON
1978-1981	IU Conversion Systems, Inc. Vice President, Research and Concept Engineering
1973-1978	WESTON
1968-1973	Drexel University Research Associate
1963-1968	Naim Mahfouz Engineering Cairo, Egypt Project Engineer

Key Projects

Planning, siting, and conceptual design of a regional sludge handling, stabilization, and land disposal facility for Envirosafe Services, Inc., Horsham, Pennsylvania.

Evaluation and conceptual design of demonstration facility for chemical stabilization and secure landfilling of chromate residuals for a confidential client.

Process development, conceptual design, operations assistance, and geotechnical engineering for handling, stabilization, and land disposal of flue gas cleaning residuals for 10 major electric power utilities.

Conducted a study on impact and potential of coal utilization on the environmental services industry. Recommended approaches to market entry and expanding scope of services.

Design of solid waste and sludge disposal facilities for Proctor and Gamble Paper Company, Philip Morris U.S.A., Federal Cartridge Corporation, Cities Services Company, and several confidential clients.

Evaluation of landfill and concept design of leachate control plan for City of Bethlehem, Pennsylvania.

Evaluation of a landfill and development of a rehabilitation/reconstruction plan for New Castle County, Delaware.

Professional Profile

Alice L. Lenthe

Registration

Engineer-in-training in the Commonwealth of Pennsylvania.

Fields of Competence

Solid waste and hazardous waste management including collection, storage, and disposal; industrial waste disposal and management; permitting; stormwater management; surveying.

Experience Summary

Three years engineering experience in waste management, (both wastewater and solid/hazardous waste) including interaction with Federal, state, and local governmental agencies and industrial clients.

Credentials

B.S. Civil Engineering—Lehigh University, with Highest Honors (1978)

American Society of Civil Engineers

Society of Women Engineers

Tau Beta Pi (Engineering Honor Society)

Chi Epsilon (Civil Engineering Honor Society)

Recipient of Lehigh University Presidential Prize

Continuing Education—Urban Hydrology and Storm Water Management. HEC-2 Flood Plain Hydraulics

Employment History

1978-Present	WESTON
1976-1978 Part-time	Joseph F. Clark, Registered Land Surveyor Member of Survey Party
1975-1976 Part-time	Westinghouse Electric Corporation Materials Engineering Assistant

Key Projects

Engineering evaluation of potential disposal sites for low-level radioactive waste.

Development of plant-wide solid and hazardous waste management plan for steel production facility in Indiana.

Preparation of Research Conservation and Recovery Act facility plans and hazardous waste transport criteria for a precious metals processing facility in Pennsylvania.

Hazardous waste management survey for an electric utility (coal, oil, and nuclear-powered sites) in Pennsylvania.

Development of facility closure plan and permitting of a disposal facility for a hazardous waste processor in New Jersey.

Development of an emergency cleanup plan and cost estimate for a major polychlorinated biphenyl spill in Youngsville, Pennsylvania.

Preparation of best management practice, emergency response, and closure plans for several disposal facilities of a major hazardous waste disposal corporation in Pennsylvania.

Permitting of a secure landfill for a steel production facility in Pennsylvania.

Development of solid waste management plan for Camden County, New Jersey.

Professional Profile

Kenneth L. Seace

Fields of Competence

Laboratory analysis of water, wastewater, and gas samples, involving instrumental and wet chemistry methods; air pollution source surveys and ambient air surveys; operation, calibration, and maintenance of laboratory and field sampling and analytical equipment.

Experience Summary

Twelve years laboratory and field experience in air pollution and wastewater sampling and analysis, including emission source studies, ambient air surveys, instrumental and wet chemistry analysis, and related calculation and data interpretation activities.

Credentials

Business Management — St. Joseph's College, Philadelphia College of Textiles & Science

Inorganic Chemistry — Philadelphia College of Textiles & Science

Licensed Bacteriologist for Multi-Tube and Membrane Filter

Employment History

1967-Present	Weston
1967	Lukens Steel Company Management Trainee
1966-1967	U.S. Army
1965-1966	Lukens Steel Company Furnace Heat Observer, Metallurgist

Key Projects

Participated in the Naval Ship Research and Development Center Inter-Laboratory Study of Oil-in-Water Analysis by Infrared Spectrophotometry.

Assisted in the analysis of samples generated by the NAVCER (U.S. Navy) in survey of three naval installations for the characterization of the domestic wastewater effluents.

Analyst for EPA-sponsored guidelines study of the Organic Chemicals, Rubber, and Steam Generating and Noncontact Cooling Water industries.

Laboratory Analyst for the Delaware College of Marine Studies program of metals identification in marine sediment samples.

EPA Testing Project on mercuries by Atomic Absorption (flameless method), including mercury analysis on soil, wheat, earthworms, and rodents.

Participated in air-pollution source surveys in the ceramics, sponge iron, steel, fertilizer, chemicals and other industries involving such contaminants as particulates, nitrogen oxides, sulfur oxides, fluorine, ammonia, phosphates, carbon monoxides, silica, and chlorides.

Participated in field evaluation of air pollution control systems (scrubbers and precipitators) at two municipal incinerators in the City of New York, involving sampling and analysis of particulates, sulfur dioxide, chlorides, organic acids, ammonia, aldehydes, nitrogen oxides, ozone, carbon monoxides, and hydrocarbons.

Professional Profile

Nancy H. Goldberg

Fields of Competence

Laboratory analyses of water, wastewater and gaseous samples, utilizing wet-chemical, gas chromatography, and infrared procedures; source emission testing.

Experience Summary

Three years of environmental analytical laboratory experience in water, wastewater, and air pollution analysis. Instrumentation includes atomic absorption, gas chromatography, and TOC analyzers.

Credentials

B.S. in Chemistry — Cook College, Rutgers University (1976)

Employment History

1977-Present	Weston
1976-1977	Pandullo/Quirk Associates Chemist
1976	Heinz, U.S.A. Laboratory Analyst

Key Projects

Chief analyst on a confidential client decontamination study of nearby wells and streams for organic contaminants.

Industry coverage in source-emissions testing: pulp and paper mills; glass-manufacturing plants; kitty litter plants; fossil-fuel fired steam generators.

Air-contaminant testing experience: particulates; NO_x; SO_2 and SO_3; hydrocarbons; carbon monoxide; carbon dioxide.

Chief analyst on a confidential client process study of organic contaminants; ethylene dichloride, propylene dichloride, divinyl benzene, ethyl vinyl benzene, diethyl benzene and styrene.

Professional Profile

Thomas W. Kelley

Fields of Competence

Experienced in all phases of Infiltration/Inflow analyses and sewer system evaluation studies, including surface inspection, physical inspection, walk-throughs, and flow measurements; wastewater laboratory analysis.

Experience Summary

Four years experience as a crew chief for Infiltration/Inflow analyses and Sewer System Evaluation Survey in systems as extensive as 500 miles. Responsibilities included job supervision, job safety data production and analysis, and quality control.

Employment History

1979-Present	Weston
1977-1979	Southern Line Cleaning
1974-1977	Alan Wood Steel
1969-1973	U.S. Navy

Key Projects

Industrial waste characterization and flow measurements for a major oil refinery in New Jersey.

Industrial waste characterization, weir installation, and flow measurements for a large industrial facility in Delaware.

Infiltration/Inflow and Sewer System Evaluation Survey of 500 miles of sewers in the City of Philadelphia.

Infiltration/Inflow study for 13 separate municipalities in Camden County, New Jersey.

Crew chief in complete charge of all field work for Infiltration/Inflow and Sewer System Evaluation Survey in Hightstown, New Jersey.

Detailed flow isolation for Radnor Township, Pennsylvania. Project involved pinpointing infiltration from manhole to manhole.

Tracing and locating infiltration using lithium and instantaneous flow measurements for East Windsor, New Jersey.

Flow isolated Marple, Haverford, Newtown, and Tredyffrin Townships in Pennsylvania at subsystems and calibrated metering stations.

Professional Profile

APPENDIX B

THEORETICAL AND OPERATIONAL PRINCIPLES OF GROUND PENETRATING RADAR (GPR)

GROUND PENETRATING RADAR

Introduction

GPR is used on land surveys to map interfaces such as changes in soil types, bedrock and other soil and geological characteristics. It is also used to locate artifacts such as pipes, barrels, cables, and conduits. When GPR is used in over-water surveys, it is capable of mapping the same interfaces as on land. It can also be used to measure ice thickness and to profile the bottom of rivers and lakes.

Components

GPR is an impulse radar system that provides a continuous profile of subsurface conditions by radiating electromagnetic pulses into the earth (or water) and displaying the reflections from surface and subsurface interfaces on a strip-chart recorder. The system is composed of five major components:

- Power distribution unit - provides proper AC/DC voltages to all GPR equipment
- Radar Control Unit - Triggers antenna transmitter and processes received data
- Antenna Transceiver - Radiates electromagnetic pulses into the earth and receives reflections
- Graphic Recorder - Produces chart of the subsurface profile
- Tape Recorder - Records data on the tape for future processing

The radar control unit triggers the antenna transmitter to produce the electromagnetic pulse, which it shapes into Quasi-Gaussian form and radiates it through the broad-band antenna. The transmitted pulse travels through the subsurface until it encounters an interface (i.e. a change or discontinuity in electrical properties such as a soil or geological boundary or an imbedded object such as a drum, boulder, etc.). Once the pulse reaches the interface, a

portion of the signal is reflected and the remaining portion continues through the interface. The reflected pulse is collected by the antenna transceiver, and it is this signal which is recorded as data. (See Figure A-1)

The reflected signals received by the antenna receiver are converted to the audio frequency range which is processed by the radar control unit. Processing is an operator-initiated procedure which selects and enhances that portion of the data which is of greatest importance to the objective of the survey. The processed data is then sent to the graphic recorder which produces a permanent chart or profile of the subsurface interfaces. The processed data may also be sent to the tape recorder, thereby providing a data log which can be reprocessed or printed at a later date. The primary advantage of tape recording data is that its use allows data to be taken as much as 16 times faster than with the graphic recorder.

Signal Structure and Resulting Profile

An example of GPR signal structure and the resulting profile is shown in Figure A-2. The received signal consists of three components:

- Transmitted pulse
- Surface reflection
- Interface reflections

A continuous stream of received pulses is fed into the graphic recorder and a profile is produced. The horizontal scale is dependent upon the traverse speed of the antenna across the ground. The vertical scale is dependent upon the travel time of the GPR pulse. The travel time may be converted into a depth scale if either the dielectric constant of the medium being probed or the depth to a specific interface is known. Depth would be calculated by the following relationship:

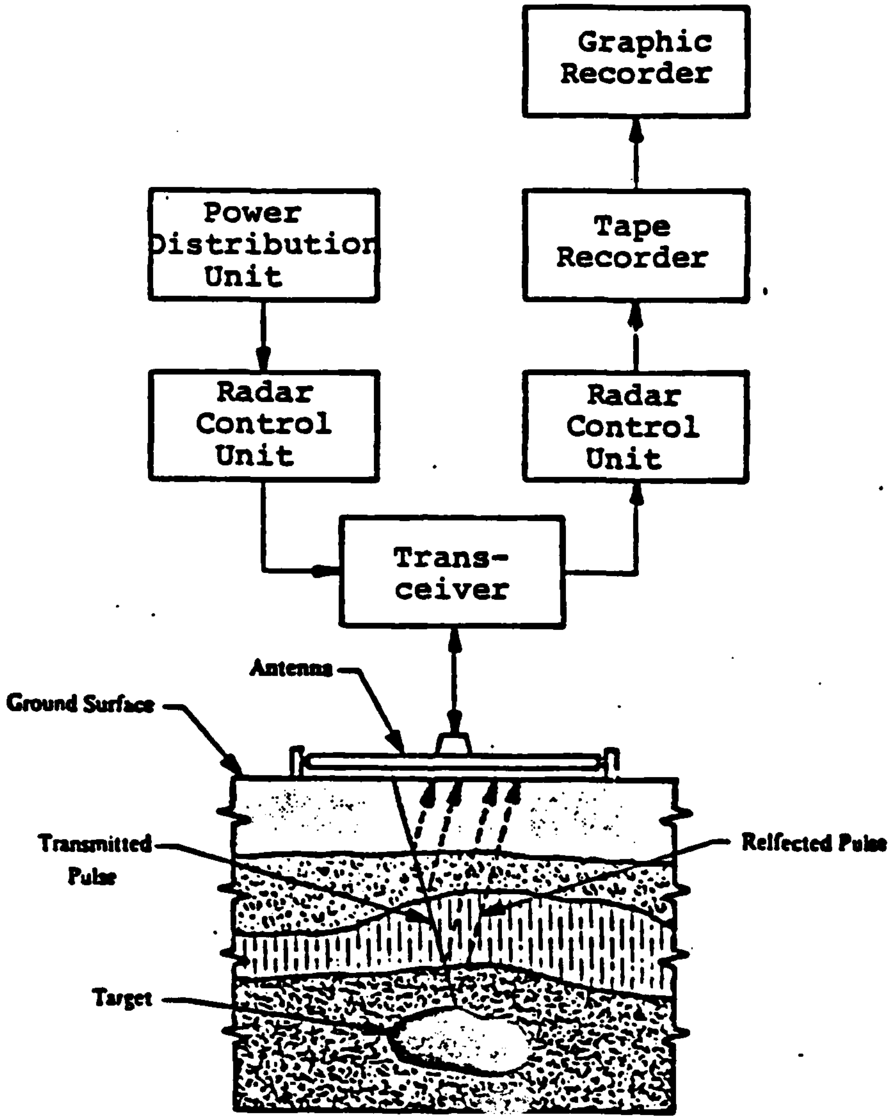
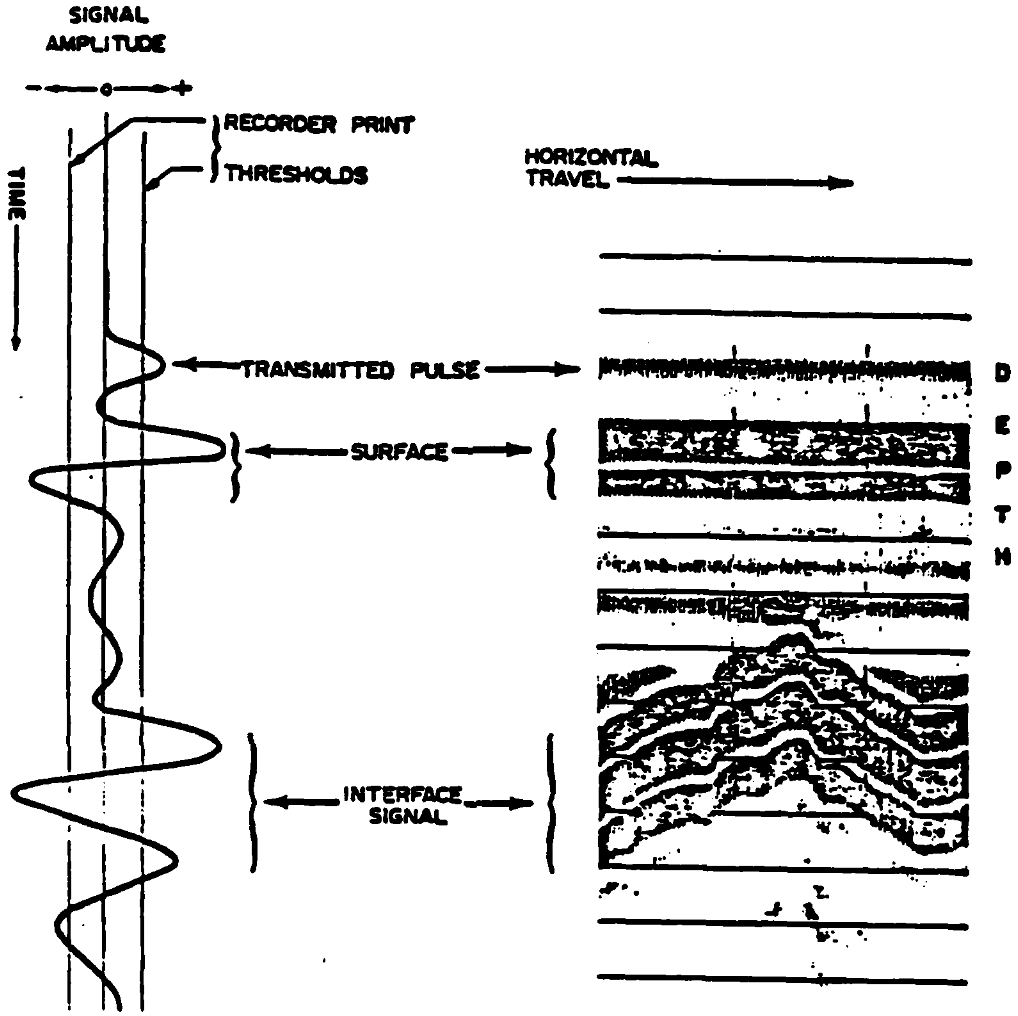


Figure A-1: Block Diagram of the Ground Penetrating Radar (GPR) Unit.



Sketch of a Single GPR Pulse and its Reflections as Seen by the Receiver.

Example of Profile Information as Displayed by the Graphic Recorder.

Figure A-2: Example of Ground Penetrating Radar Profile Data.

$$D = \frac{ct}{2 \; Er} = \frac{Vmt}{2}$$

Where:

D = Depth in feet

C = Velocity of light

t = Pulse travel time in nanoseconds

Er = Relative dielectric constant of material

Vm = Velocity of propagation in material = $\frac{C}{Er}$

The conductivities and dielectric constants of various materials are presented in Table A-1. The presence of water and the chemical state of the water has the greatest effect on the dielectric constant and conductivity.

The penetration depth of the GPR system is dependent upon the effective conductivity of the material being probed. In highly conductive materials, the GPR signal is rapidly attenuated, severely limiting the penetration depths. For example, penetration through wet clay is only about five feet, and penetration in sea water deteriorates to less than a foot. This is in contrast to penetration depths through low conductivity materials, such as dry sand or rock, which can reach depths of perhaps as much as 100 feet. The depth of penetration of the signal is also dependent upon the frequency content of the pulse. Generally, lower frequency components propagate to the greatest depths, but higher frequency components provide to better resolution. Therefore, selection of the antenna with the proper frequency response is important to achieving the desired results.

Interpretation of GPR Data

The graphic recorder produces a profile by printing strong signals (amplitudes higher than print threshold) as black and weak signals as white (see Figure A-2). The result is the display of dark bands that extend throughout the

profile at varying depths. These bands represent the reflection from an interface between two materials.

The antenna has a fairly broad radiation pattern within the ground. The radiation pattern is conical in shape with the apex at the center of the antenna and an included angle of approximately 90°. For flat reflecting surfaces, such as soil interfaces, it is the energy that is directed straight down and reflected that the antenna receives. However, for round objects such as pipes and barrels, there are many surfaces which are normal to the antenna pattern as it passes over the object at right angles. The result is a unique signature as shown in Figure A-3.

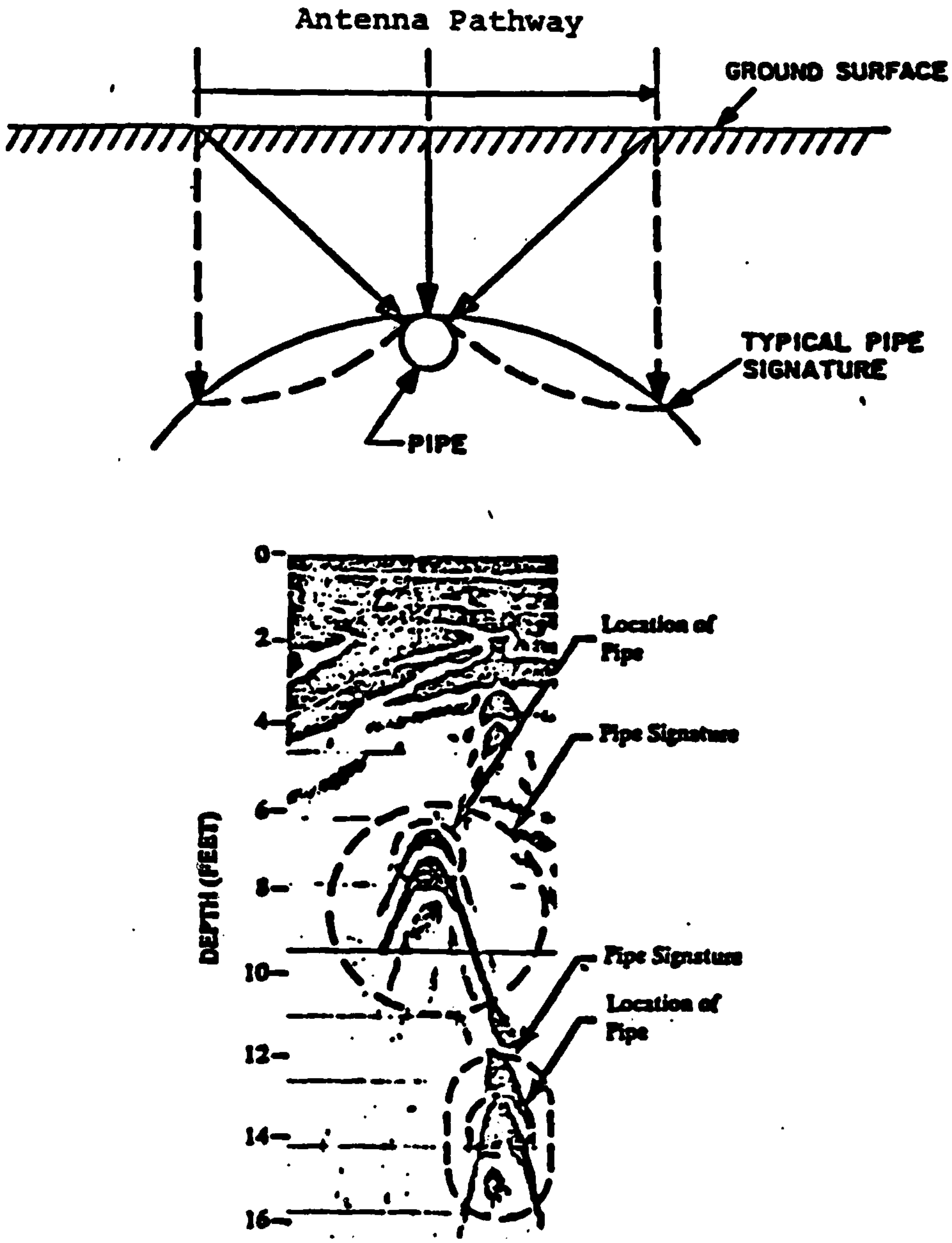
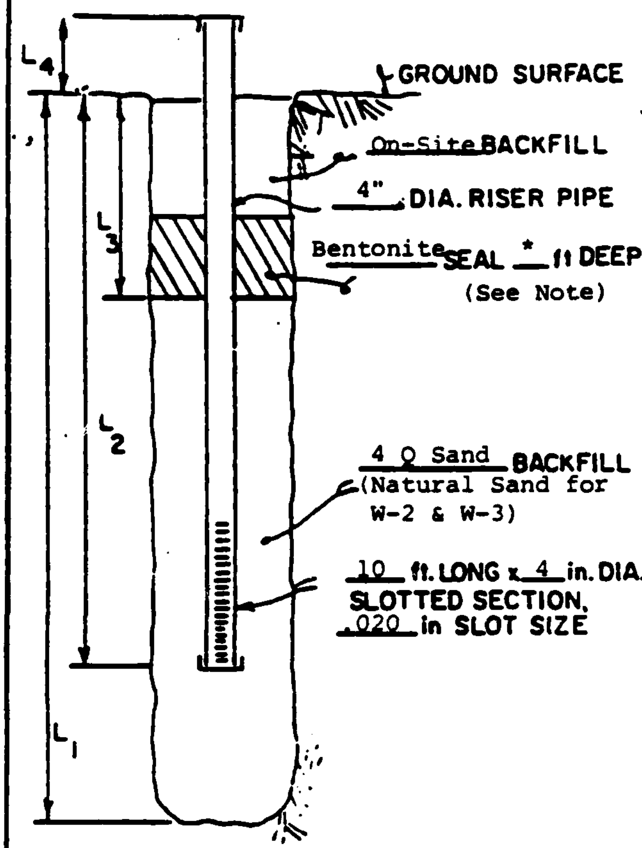


Figure A-3: Typical Signature of a Buried Pipe.

APPENDIX C

BORING LOGS AND WELL CONSTRUCTION SUMMARIES



WELL NO.	L_1	L_2	L_3	L_4
W-1	14.5'	14.5'	4.0'	2.5'
W-2	35.0'	32.0'	14.0'	2.5'
W-3	32.0'	27.0'	14.0'	2.0'
W-4	24.0'	23.5'	8.0'	2.5'

Note:

Bentonite Seal

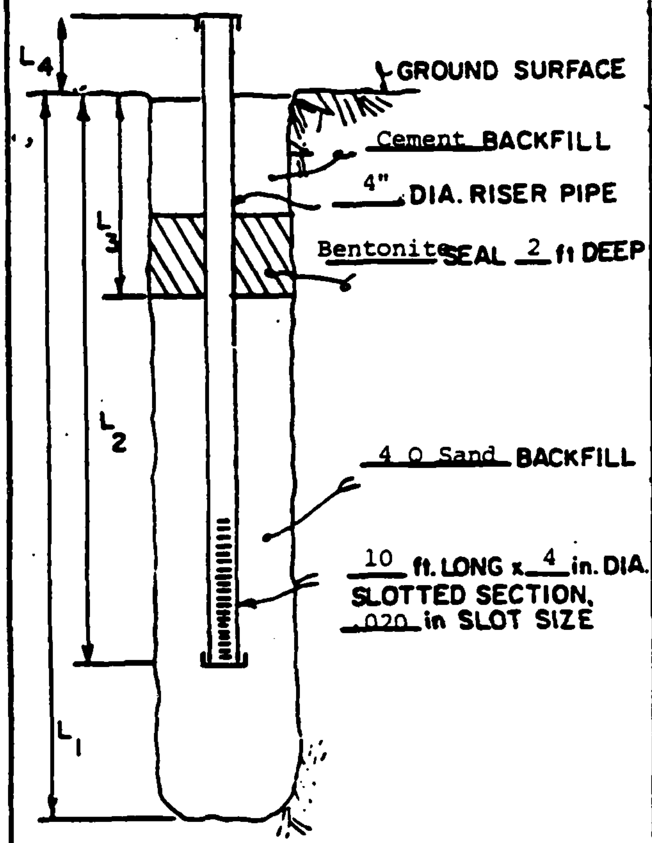
W-1 - 0.5' deep
W-2 - 5.0' deep
W-3 - 5.0' deep
W-4 - 2.0' deep

EMPIRE SOILS INVESTIGATIONS, INC.

MONITORING WELL DETAILS

GROUNDWATER MONITORING WELLS
GRIFFISS AIR FORCE BASE
ROME, NEW YORK

DR BY SMC	SCALE -------	PROJ NO GDS-81-51
CK'D BY	DATE 12-15-81	DRWG NO 1



WELL NO.	L_1	L_2	L_3	L_4	Water Level
B-5	20.0'	20.0'	5.0'	2.0'	2.6'
B-6	15.0'	15.0'	4.0'	2.0'	1.7'
B-7	17.0'	17.0'	5.0'	2.0'	1.3'
B-8	35.0'	30.0'	7.0'	2.0'	5.9'
B-9	35.0'	28.0'	8.0'	2.0'	2.4'

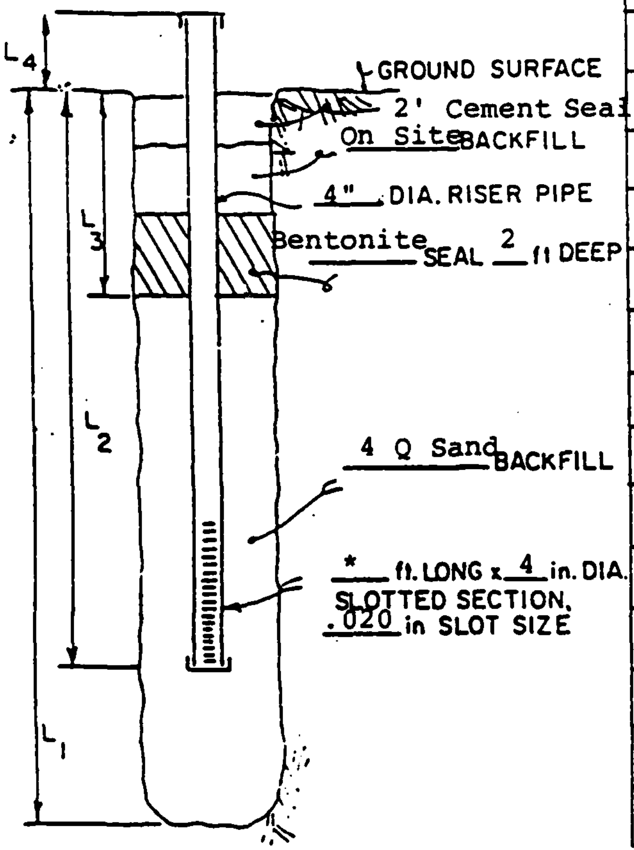
Note:
Water level readings recorded after the installation of each well.

EMPIRE SOILS INVESTIGATIONS, INC.

MONITORING WELL DETAILS

GROUNDWATER MONITORING WELLS
GRIFFISS AIR FORCE BASE
ROME, NEW YORK

DR BY SMC	SCALE --------	PROJ NO GDS-81-51
CK'D BY	DATE 12-31-81	DRWG NO 2



WELL NO.	L_1	L_2	L_3	L_4
P-1	22.0'	22.0'	7.0'	2.0'
P-2	13.0'	13.0'	6.0'	2.0'
P-3	17.5'	17.0'	8.0'	2.0'
P-4	36.5'	32.0'	20.0'	2.0'
P-5	20.5'	20.0'	7.0'	2.0'

*Note: Screen Length

P-1	10.0'
P-2	5.0'
P-3	5.0'
P-4	10.0'
P-5	5.0'

EMPIRE SOILS INVESTIGATIONS, INC.

MONITORING WELL DETAILS

GROUNDWATER MONITORING WELLS
GRIFFISS AIR FORCE BASE
ROME, NEW YORK

DR BY MAL	SCALE N/A	PROJ NO GDS-81-51A
CK'D BY	DATE 5/6/82	DRWG NO 1

GENERAL INFORMATION & KEY TO SUBSURFACE LOGS

The Subsurface Logs attached to this report present the observations and mechanical data collected by the driller while at the site, supplemented by classification of the materials removed from the borings as determined through visual identification by technicians in the laboratory. It is cautioned that the materials removed from the borings represent only a fraction of the total volume of the deposits at the site and may not necessarily be representative of the subsurface conditions between adjacent borings or between the sampled intervals. The data presented on the Subsurface Logs together with the recovered samples will provide a basis for evaluating the character of the subsurface conditions relative to the proposed construction. The evaluation must consider all the recorded details and their significance relative to each other. Often analyses of standard boring data indicate the need for additional testing and sampling procedures to more accurately evaluate the subsurface conditions. Any evaluations of the contents of this report and the recovered samples must be performed by Professionals having experience in Soil Mechanics and Foundation Engineering. The information presented in the following defines some of the procedures and terms used on the Subsurface Logs to describe the conditions encountered.

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① The figures in the Depth column defines the scale of the Subsurface Log.

② The Sample column shows, graphically, the exact depth range from which a sample was recovered. See Table I for a description of the symbols used to signify the various types of samples.

③ The Sample No. is used for identification on sample containers and/or Laboratory Test Reports.

④ Blows on Sampler – shows the results of the "Penetration Test", recording the number of blows required to drive a split spoon sampler into the soil beneath the casing. The number of blows required for each six inches penetration is recorded. The total number of blows required for the last 12 inches of penetration are summarized in the "N" column. The outside diameter of the sampler, the hammer weight and the length of drop are noted at the bottom of the Subsurface Log.

⑤ Blows on Casing – shows the number of blows required to advance the casing a distance of 12 inches. The casing size, the hammer weight and the length of drop are noted at the bottom of the Subsurface Log. If the casing is advanced by means other than driving, the method of advancement will be indicated in the Notes column or under Method of Investigation at the bottom of the Subsurface Log.

⑥ All recovered soil samples are reviewed in the laboratory by technicians. The visual descriptions are made on basis of the sample as recovered and in accordance with the Unified Classification System. Guide Lines for the terms used in descriptions are presented in Tables II and III. The description of the relative soil compactness or consistency is based upon the penetration records as defined in Table IV. The description of the soil moisture is based upon the condition of the sample as recovered. The moisture condition is described as dry, damp, moist or wet. Water used to advance the boring may have affected the in-situ moisture content of the sample. Special terms are used as required to describe materials in greater detail, several such terms are listed in Table V. When sampling gravelly soils with a standard two-inch diameter split spoon, the true percentage of gravel is often not recovered due to the relatively small sampler diameter. The presence of boulders and large gravel is sometimes, but not necessarily, detected by an evaluation of the casing and sampler blows or through the "action" of the drill rig as reported by the driller.

⑦ The description of rock shown is based upon the recovered rock core. Terms frequently used in the description are included in Table VI.

⑧ Miscellaneous observations and procedures noted by the driller are shown in this column, including water level observations. It is important to realize that the reliability of the water level observations depend upon the soil type (water does not readily stabilize in a hole through fine grained soils), and that drill water used to advance the borings may have influenced the observations. The ground water level typically will fluctuate seasonally. One or more perched or trapped water levels may exist in the ground seasonally. All the available readings should be evaluated. If definite conclusions cannot be made, it is often prudent to examine the conditions more thoroughly through test pit excavations or water observation installations.

⑨ The length of core run is defined as length of penetration between retrievals of the core barrel from the bore hole, expressed in feet and tenths of feet. The core recovery expresses the length of core recovered from the core barrel per core run, in percent. The size core barrel used is also noted. The more commonly used sizes of core barrels are denoted "AX" and "NX". The "NX" core, being larger in diameter than "AX" core, often produces better recovery, and is frequently utilized where accurate information regarding the geologic conditions and engineering properties is needed. The "NX" core barrel requires the use of four inch diameter casing.

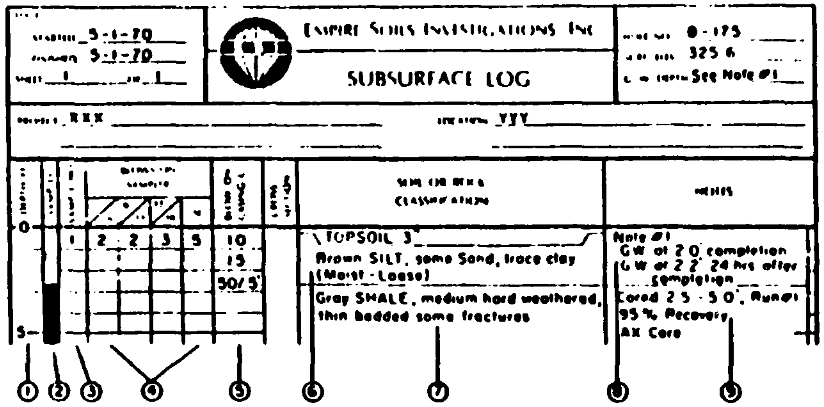


TABLE I

	Split Spoon Sample
	Shelby Tube Sample
	Auger or Pit Sample
	Rock Core

TABLE II

Identification of soil type is made on basis of an estimate of particle sizes, and in the case of fine grained soils also on basis of plasticity.

Soil Type	Soil Particle Size	
Boulder	>12"	
Cobble	3" – 12"	
Gravel - Coarse	3" – 3/4"	Coarse Grained (Granular)
- Fine	3/4" – #4	
Sand - Coarse	#4 – #10	
- Medium	#10 – #40	
- Fine	#40 – #200	
Silt - Non Plastic (Granular) Clay - Plastic (Cohesive)	<#200	Fine Grained

TABLE III

The following terms are used in classifying soils consisting of mixtures of two or more soil types. The estimate is based on weight of total sample.

Term	Percent of Total Sample
"and"	35 - 50
"some"	20 - 35
"little"	10 - 20
"trace"	less than 10

(When sampling gravelly soils with a standard split spoon, the true percentage of gravel is often not recovered due to the relatively small sampler diameter.)

TABLE IV

The relative compactness or consistency is described in accord with the following terms.

Granular Soils		Cohesive Soils	
Term	Blows per Foot, N	Term	Blows per Foot, N
Loose	< 10	Very Soft	< 2
Firm	11 - 30	Soft	3 - 5
Compact	31 - 50	Medium	6 - 15
Very Compact	> 51	Stiff	16 - 25
		Hard	> 26

(Large particles in the soils will often significantly influence the blows per foot recorded during the Penetration Test.)

TABLE V

Varved -	Alternating layers, seams, and partings of soils
Layer -	Soil deposit more than 6" thick
Seam -	Soil deposit less than 6" thick
Parting -	Soil deposit less than 1/8" thick
Uniform -	All grains are of about the same diameter

TABLE VI

Rock Classification Terms

Term		Meaning
Hardness	Soft	Scratched by fingernail
	Medium Hard	Scratched easily by penknife
	Hard	Scratched with difficulty by penknife
	Very Hard	Cannot be scratched by penknife
Weathering	Very Weathered Weathered Sound	Judged from the relative amounts of disintegration, iron staining, core recovery, clay seams, etc.
Bedding	Laminated	Natural breaks in Rock Layers (< 1")
	Thin bedded	(1" – 4")
	Bedded	(4" – 12")
	Thick bedded	(12" – 36")
	Massive	(> 36")

(Fracturing refers to natural breaks in the rock oriented at some angle to the rock layers.)

DS-12

DATE
STARTED 11-19-81
FINISHED 11-19-81
SHEET 1 OF 1

EMPIRE SOILS INVESTIGATIONS, INC.

SUBSURFACE LOG

HOLE NO. W-1
SURF ELEV. By Others
G. W. DEPTH See Note

PROJECT Groundwater Monitoring Wells
LOCATION Griffiss Air Force Base
Rome, New York

DEPTH-FT	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0	1	3	4	4	8		TOPSOIL 0.3' Brown, coarse-fine SAND, Some fine Gravel, little silt (Moist-Loose)	Note: At completion, water level @10.0' inside 10.0' of casing.
5	2	7	7	8	15		Gravel content increases 9.5'	
10	3	62	75	91	166		Grey, SILT, coarse-fine SAND, Some Gravel, rock fragments (Wet-Very Compact)	
							Boring Terminated @11.5'	Monitoring well installed. See accompanying chart for installation details.
15								

N = No blows to drive 2 "spoon 12 "with 140 lb. pin wt. falling 30 "per blow
C = No blows to drive ____ "casing ____ "with ____ lb. weight falling ____ "per blow
CLASSIFICATION Visual by Engineering Technician
METHOD OF INVESTIGATION 6 1/4" I. D. Hollow Stem Auger Casing

DATE	EMPIRE SOILS INVESTIGATIONS, INC.	
STARTED 11-18-81		HOLE NO. W-1A
FINISHED 11-18-81	SUBSURFACE LOG	SURF. ELEV. By Others
SHEET 1 OF 1		G. W. DEPTH See Note

PROJECT Groundwater Monitoring Wells

LOCATION Griffiss Air Force Base
Rome, New York

DEPTH-FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0								No Sampling from 0-10.0'	Note: At completion, water level @9.0' inside 10.0' of casing.
5									
10		1	26	30	35	65		Grey, SILT & coarse-fine SAND, Some Gravel, rock fragments (Moist-Very Compact)	
								Boring Terminated @11.5'	
15									

N = No blows to drive 2 "spoon 12 "with 140 lb. pin wt. falling 30 "per blow.

C = No blows to drive ____ "casing ____ "with ____ lb. weight falling ____ "per blow.

CLASSIFICATION Visual by Engineering Technician

METHOD OF INVESTIGATION 6 1/4" I. D. Hollow Stem Auger Casing

DATE
STARTED 11-23-81
FINISHED 11-25-81
SHEET 1 OF 1

EMPIRE SOILS INVESTIGATIONS, INC.

SUBSURFACE LOG

HOLE NO. W-2
SURF. ELEV. By Others
G. W. DEPTH See Note

PROJECT Groundwater Monitoring Wells

LOCATION Griffiss Air Force Base
Rome, New York

DEPTH-FT	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0	1	2	2				TOPSOIL 0.5'	Note: Water level @13.5' inside 15.0' of casing.
		4	5		6		Brown, SILT & fine SAND, Some fine Gravel (Moist-Loose)	
5	2	5	6				Brown, fine SAND, little silt (Damp-Firm)	
		7	7		13			
10	3	18	18	20	38		grades similar with trace fine gravel (Damp-Compact)	
15	4	9	9	13	22		Brown, fine SAND, Some Silt (Saturated-Firm)	
20	5	1	3	3	6			
							No Sampling from 21.5'-35.0'	
25								
30								
35							Boring Terminated @35.0'	Monitoring well installed. See accompanying chart for installation details.

N = No blows to drive 2 "spoon 12 "with 140 lb. pin wt. falling 30 "per blow.
C = No blows to drive ____ "casing ____ "with ____ lb. weight falling ____ "per blow

CLASSIFICATION Visual by Engineering Technician

METHOD OF INVESTIGATION 6 1/4" I. D. Hollow Stem Auger Casing

EMPIRE SOILS INVESTIGATIONS, INC.

SUBSURFACE LOG

DATE
STARTED 11-23-81
FINISHED 11-24-81
SHEET 1 OF 1

HOLE NO. W-3
SURF. ELEV. By Others
G W DEPTH See Note

PROJECT Groundwater Monitoring Wells
LOCATION Griffiss Air Force Base
Rome, New York

DEPTH-FT	SAMPLES	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	1	3				TOPSOIL 0.4'	Note: On 11-23-81, no water with 15.0' of casing driven. On 11-24-81, water level @14.0' inside 15.0' of casing. No sampling @5.0' and 25.0' at inspectors request.
			5	8		8		Brown, fine SAND, little silt, trace fine gravel (Moist-Loose)	
5									
10		2	4	4					
			4	4		8			
15		3	5	9	10	19		Brown, SILT, little fine sand (Wet-Firm) 17.0'	
								Brown, SILT & fine SAND, trace fine gravel, occasional cobble (Wet-Firm)	
20		4	16	17	12	29			
25									
30		5	5	5				Brown, fine SAND, Some Silt (Saturated-Firm)	
			8	9		13			
								Boring Terminated @32.0'	Monitoring well installed. See accompanying chart for installation details.
35									

N = No. blows to drive 2 "spoon 12 "with 140 lb. pin wt. falling 30 "per blow
C = No. blows to drive ____ "casing ____ "with ____ lb. weight falling ____ "per blow

CLASSIFICATION Visual by Engineering Technician

METHOD OF INVESTIGATION 6 1/4" I. D. Hollow Stem Auger Casing

DATE

STARTED 11-25-81
FINISHED 11-27-81
SHEET 1 OF 1

EMPIRE SOILS INVESTIGATIONS, INC.

SUBSURFACE LOG

HOLE NO. W-4
SURF. ELEV. By Others
G. W. DEPTH See Note

PROJECT Groundwater Monitoring Wells

LOCATION Griffiss Air Force Base
Rome, New York

DEPTH-FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0								TOPSOIL 0.3'	Note:
								Sampled from auger-Dark Brown, SILT, Some coarse-fine Sand & Gravel, roots, damp	On 11-25-81, water level @16.5' inside 20.0' of casing. On 11-27-81, water level @15.0' inside 20.0' of casing.
5									
10		2	7	10	7	17		Brown, coarse-fine SAND & GRAVEL, little silt (Moist-Firm)	
								No Sampling from 11.5'-24.0'	
15									
20									
25								Boring Terminated @24.0'	

N = No blows to drive 2 "spoon 12 "with 140 lb. pin wt. falling 30 "per blow

C = No blows to drive ____ "casing ____ "with ____ lb. weight falling ____ "per blow

CLASSIFICATION Visual by Engineering Technician

METHOD OF INVESTIGATION 6 1/4" I. D. Hollow Stem Auger Casing

DATE

STARTED 12-15-81

FINISHED 12-16-81

SHEET 1 OF 1

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO B-5

SURF. ELEV By Others

G.W. DEPTH See Note

PROJECT Groundwater Monitoring Wells

LOCATION Griffiss Air Force Base, Rome, New York

DEPTH	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOWS ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	1	2				TOPSOIL 1.0'	Note: Groundwater first encountered @2.3'. At completion of boring, with casing removed, water level @2'.
			3	5		5		Grey, SILT, Some Clay, trace embedded twigs & fiberous organics (Moist-Medium) 3.0'	
5		2	1	2	1	3		Black, PEAT & WOOD (Wet-Loose) 6.3'	
								Grey, coarse-fine SAND & fine GRAVEL, Some Silt (Moist-Loose) 11.0'	
10		3	1	1	7	8		Driller's Note: Grey SILT, Some Sand & Gravel (TILL) 12.5'	
								Dark Grey fine ROCK FRAGMENTS, trace silt (Wet-Very Compact)	
15		4	100/.3'						
20								Boring Terminated @20.0'	Monitoring well installed. See accompanying chart for installation details.

N = No. blows to drive 2 spoon 12 with 140 lb pin wt falling 30 per blow

C = No. blows to drive ___ casing ___ with ___ lb weight falling ___ per blow

CLASSIFICATION Visual by Engineering Technician

METHOD OF INVESTIGATION 6 1/4" I. D. Hollow Stem Auger Casing

R T Form H

DATE
STARTED 12-16-81
FINISHED 12-16-81
SHEET 1 OF 1

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO B-6
SURF ELEV By Others
C.W DEPTH See Note

PROJECT Groundwater Monitoring Wells
LOCATION Griffiss Air Force Base Rome, New York

DEPTH	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOWS ON CASING	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	1	2				TOPSOIL 0.3'	Note:
			3	2		5		Brown, SILT, little sand, trace clay & embedded twigs, fiberous organics (Moist-Loose)	Groundwater first encountered @3.0'. At completion of boring, water level @2.3' inside 15' of casing.
5		2	5	5	4	9		grades, wet @3' Brown, medium-fine SAND & SILT (Wet-Loose) 8.0'	
								Dark Grey, weathered SHALE (Wet-Very Compact)	
10		3	100/.3'						
15								Boring Terminated @15.0'	Monitoring well installed. See accompanying chart for installation details.
20									

N = No blows to drive 2 spoon 12 with 140 lb pin wt falling 30 per blow

C = No blows to drive ___ casing ___ with ___ lb weight falling ___ per blow

CLASSIFICATION Visual by Engineering Technician

METHOD OF INVESTIGATION 6 1/4" I. D. Hollow Stem Auger Casing

DATE
STARTED 12-17-81
FINISHED 12-17-81
SHEET 1 OF 1

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO. B-7
SURF ELEV By Others
G. W. DEPTH See Note

PROJECT ~~Groundwater Monitoring Wells~~
LOCATION ~~Griffiss Air Force Base~~ Rome, New York

DEPTH FT	SAMPLES	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOWS ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	1	1				TOPSOIL 0.6'	Note: Groundwater first encountered @3.0' At completion of boring, water level @1.8' inside 17' of casing.
			1	2		2		Grey, SILT & CLAY, little organic silt, trace embedded twigs & fiberous organics (Moist-Soft) 3.0'	
5		2	1	1	2	3		Grey, fine SAND & SILT (Saturated-Loose) 9.0'	
10		3	4	3	5	8		Dark Grey, coarse-fine SAND & GRAVEL, little silt (Saturated-Loose) 12.0'	
15		4	26	100/.3'				Dark Grey, weathered SHALE (Wet-Very Compact)	
								Boring Terminated @17.0'	Monitoring well installed. See accompanying chart for installation details.
20									

N = No. blows to drive 2 spoon 12 with 140 lb pin wt. falling 30 per blow
C = No. blows to drive ____ casing ____ with ____ lb weight falling ____ per blow
CLASSIFICATION Visual by Engineering Technician
METHOD OF INVESTIGATION 6 1/4" I. D. Hollow Stem Auger Casing

B-7 Form H

EMPIRE SOILS INVESTIGATIONS INC — **SUBSURFACE LOG**

DATE
STARTED 12-17-81
FINISHED 12-18-81
SHEET 1 OF 1

HOLE NO B-8
SURF ELEV By Others
G.W. DEPTH See Note

PROJECT Groundwater Monitoring Wells
LOCATION Griffiss Air Force Base, Rome, New York

DEPTH (ft)	SAMPLE NO	BLOWS ON SAMPLER 0-6	6-12	12-18	N	SOIL OR ROCK CLASSIFICATION	NOTES
0	1	1 / 5	5 / 7		10	TOPSOIL 0.5'	Note: Groundwater first encountered @8.0'. At completion of boring, water level @7.4' inside 35' of casing.
						Brown, medium-fine SAND & SILT (Damp-Firm) 3.5'	
5	2	31	27	30	57	Brown, medium-fine SAND & SILT, Some Gravel (Wet-Very Compact) 9.0'	
10	3	21	42	18	60	Grey, coarse-fine SAND, little fine gravel, trace silt (Wet-Very Compact) 16.0'	
15	4	1	4	41	45	Grey, fine SAND & SILT, trace gravel (Wet-Compact) 18.5'	
20	5					Grey, medium-fine SAND, Some Silt, saturated	
30	6						
35						Boring Terminated @35.0'	Monitoring well installed. See accompanying chart for installation details

N = No. blows to drive 2 spoon 12 with 140 lb pin wt falling 30 per blow
C = No. blows to drive ___ casing ___ with ___ lb weight falling ___ per blow
CLASSIFICATION Visual by Engineering Technician

METHOD OF INVESTIGATION 6 1/4" I. D. Hollow Stem Auger Casing

R T Form

DATE		EMPIRE SOILS INVESTIGATIONS INC — SUBSURFACE LOG		
STARTED	12-18-81		HOLE NO	B-9
FINISHED	12-18-81		SURF ELEV	By Others
SHEET	1 OF 1		G.W. DEPTH	See Note

PROJECT Groundwater Monitoring Wells

LOCATION Griffiss Air Force Base
Rome, New York

DEPTH	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOWS ON CASING	SOIL OR ROCK CLASSIFICATION	NOTES
0								TOPSOIL 0.5'	Note: Groundwater first encountered @3.0'. At completion of boring, water level @2.4' inside 30' of casing.
		1						Grey, fine SAND, Some Silt, saturated	
5								grades, Brown @6.0'	
10		2							
								14.0'	
15		3	2	3	5	8		Brown, coarse-fine SAND & fine GRAVEL	
								(Wet-Loose) 20.0'	
20								Brown, medium-fine SAND, Some Silt (Saturated-Firm)	
25									
30		4	3	5	6	11			
35								Boring Terminated @35.0'	Monitoring well installed. See accompanying chart for installation details.
40									

N = No. blows to drive 2 spoon 12 with 140 lb pin wt falling 30 per blow

C = No. blows to drive ______ casing ______ with ______ lb weight falling ______ per blow

CLASSIFICATION Visual by Engineering Technician

METHOD OF INVESTIGATION 6 1/4" I. D. Hollow Stem Auger Casing

E.T. Form H

DATE			
STARTED 4-20-82	**EMPIRE** SOILS INVESTIGATIONS INC	SUBSURFACE LOG	HOLE NO P-1
FINISHED 4-21-82			SURF ELEV By Others
SHEET 1 OF 1			G.W DEPTH See Note

PROJECT Groundwater Monitoring Wells

LOCATION Griffiss Air Force Base
Rome, New York

DEPTH	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOWS ON CASING	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	4	5				TOPSOIL .4'	Note: Groundwater level @ 9.5' inside casing
			5	6		10		FILL: SILT, SAND, GRAVEL & TRASH 3.5'	
								Grey, SILT, SAND & GRAVEL	
5		2	6	6	5	11			
								(Moist-Firm) 9.5'	
10		3	23	36	40	76		Grey, SILT, Some Sand and Gravel (TILL) (Damp-Very Compact)	
15		4	100/.1'					No Recovery 20.5'	
20		5	140					SHALE (Very Compact)	
								Boring Terminated @ 22.0'	Monitoring well installed. See accompanying chart for installation details.
25									

N = No blows to drive 2 spoon 12 with 140 lb pin wt falling 30 per blow

C = No blows to drive ___ casing ___ with ___ lb weight falling ___ per blow

CLASSIFICATION Visual by Driller

METHOD OF INVESTIGATION 6¼" I.D. Hollow Stem Augers

DATE STARTED 4-20-82
FINISHED 4-20-82
SHEET 1 OF 1

EMPIRE SOILS INVESTIGATIONS INC SUBSURFACE LOG

HOLE NO P-2
SURF ELEV By Others
G. W. DEPTH See Note

PROJECT Groundwater Monitoring Wells
LOCATION Griffiss Air Force Base
Rome, New York

DEPTH	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOWS ON CASING	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	1	5				TOPSOIL 0.4'	Note: Groundwater level @ 4.0' inside casing
			14	10		19		Brown, SILT, SAND & GRAVEL (Damp-Firm) 4.0'	
								Brown, SAND, trace silt	
5		2	2	2	2	4		(Wet-Loose) 10.0'	
10		3	8	16	28	44		Brown, SAND & GRAVEL (Wet) 10.5'	
								Grey, fine SAND & SILT, trace gravel (TILL) (Damp-Compact) 11.5'	Monitoring well installed. See accompanying chart for installation details.
								SHALE	
15								Boring Terminated @ $13.0'	
20									

N = No. blows to drive 2 spoon 12 with 140 lb. pin wt. falling 30 per blow
C = No. blows to drive ___ casing ___ with ___ lb. weight falling ___ per blow
CLASSIFICATION Visual by Driller
METHOD OF INVESTIGATION 6¼" I.D. Hollow Stem Augers

DATE STARTED 4-21-82

FINISHED 4-21-82

SHEET 1 OF 1

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO P-3

SURF ELEV By Others

G W DEPTH See Note

PROJECT Groundwater Monitoring Wells

LOCATION Griffiss Air Force Base
Rome, New York

DEPTH	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOWS ON CASING	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	2 / 7	1 / 7		8		TOPSOIL 0.4' Brown SAND, Some Silt (Moist-Loose)	Note: Groundwater level @ 1.0' inside casing.
5		2	2	4	8	12		grades firm	
10		3	4	18	22	40		grades compact	
15		4	42	100/.2'				15.0' SHALE	
								Boring Terminated @ 17.5'	Monitoring well installed. See accompanying chart for installation details.
20									

N - No. blows to drive 2 spoon 12 with 140 lb pin wt falling 30 per blow

CLASSIFICATION Visual by Driller

N - No. blows to drive casing with lb weight falling per blow

METHOD OF INVESTIGATION 6¼" I.D. Hollow Stem Augers

DATE			
STARTED 4-21-82	**EMPIRE** SOILS INVESTIGATIONS INC	SUBSURFACE LOG	HOLE NO P-4
FINISHED 4-22-82			SURF ELEV By Others
SHEET 1 OF 1			G W DEPTH See Note

PROJECT Groundwater Monitoring Wells

LOCATION Griffiss Air Force Base
Rome, New York

DEPTH	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOWS ON CASING	SOIL OR ROCK CLASSIFICATION	NOTES
0	1	2	2				Brown SAND, trace silt (Damp-Loose)	Note: Groundwater level @ 24.0' inside casing.
		2	3		4			
5	2	3	3	3	6			
10	3	4	7	10	17		grades firm	
15	4	5	8	11	19			
20	5	6	11	12	23			
25	6	3	7	12	19		grades (wet-firm)	
30	7	3	6	8	14			
							34.0'	
35	8	11	37	49	86		SILT, SAND & GRAVEL (TILL) (Very-Compact)	
							Boring Terminated @ 36.5'	Monitoring well installed. See accompanying chart for installation detail
40								

[illegible] 2 [illegible] 12 with 140 lb pin wt falling 30 per blow CLASSIFICATION Visual by Driller

[illegible] with ___ lb weight falling ___ per blow

[illegible] 6½" I.D. Hollow Stem Augers

DATE		EMPIRE SOILS INVESTIGATIONS INC — SUBSURFACE LOG	
STARTED	4-19-82	HOLE NO	P-5
FINISHED	4-19-82	SURF ELEV	By Others
SHEET	1 OF 1	G W DEPTH	See Note

PROJECT	Groundwater Monitoring Wells	LOCATION	Griffiss Air Force Base Rome, New York

DEPTH	SAMPLES	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOWS ON CASING	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	1	2				TOPSOIL 0.8'	
			3	4		5		Brown to Grey SILT, trace fine sand (Moist-Loose) 4.0'	
5		2	2	3	4	7		Grey CLAY (Moist-Medium) 9.0'	
10		3	2	4	5	9		Grey SAND, trace silt (Wet-Loose) 13.0'	
15		4	4	6	7	13		Grey SAND & GRAVEL, trace silt (Wet-Firm) 20.0'	
20		5	100/.5'					SHALE Boring Terminated @ 20.5'	Monitoring Well installed. See accompanying chart for installation details.
25									

N - No. blows to drive 2 " spoon 12 " with 140 lb pin wt falling 30 " per blow   CLASSIFICATION Visual by Driller

C - No. blows to drive ___ casing ___ with ___ lb weight falling ___ per blow

METHOD OF INVESTIGATION 6¼" I.D. Hollow Stem Augers

APPENDIX D

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
PRIORITY POLLUTANT LIST

GC/MS FRACTION

VOLATILE COMPOUNDS

Units of Concentration µg/L____

mg/L____

Other____

Acrolein	
Acrylonitrile	
Benzene	
Bis (chloromethyl) Ether	
Bromoform	
Carbon Tetrachloride	
Chlorobenzene	
Chlorodibromomethane	
Chloroethane	
2-Chloroethylvinyl Ether	
Chloroform	
Dichlorobromomethane	
Dichlorodifluoromethane	
1,1 Dichloroethane	
1,2 Dichloroethane	
1,1 Dichloroethylene	
1,2 Dichloropropane	
1,2 Dichloropropylene	
Ethylbenzene	
Methyl Bromide	
Methyl Chloride	
Methylene Chloride	
1,1,2,2 Tetrachloroethane	
Tetrachloroethylene	
Toluene	
1,2 Trans Dichloroethylene	
1,1,2 Trichloroethane	
1,1,1 Trichloroethane	
Trichloroethylene	
Trichlorofluoromethane	
Vinyl Chloride	
Other	

GC/MS FRACTION

ACID COMPOUNDS

Units of Concentration µg/L ________

mg/L ________

Other ________

2 Chlorophenol	
2,4 Dichlorophenol	
2,4 Dimethylphenol	
4,6 Dinitro-O-Cresol	
2,4 Dinitrophenol	
2 Nitrophenol	
4 Nitrophenol	
P Chloro-M-Cresol	
Pentachlorophenol	
Phenol	
2,4,6 Trichlorophenol	
Other	

GC/MS FRACTION

BASE/NEUTRAL COMPOUNDS

Units of Concentration µg/L ______

mg/L ______

Other ______

Acenaphthene	______	Diethyl Phthalate	______
Acenaphthylene	______	Dimethyl Phthalate	______
Anthracene	______	Di-N-Butyl Phthalate	______
Benzidine	______	2,4 Dinitrotoluene	______
Benzo(a) Anthracene	______	2,6 Dinitrotoluene	______
Benzo(a) Pyrene	______	Di-N-Octyl Phthalate	______
3,4 Benzo-fluoranthene	______	1,2 Diphenyl hydrazine	______
Benzo(ghi) Perylene	______	Fluoranthene	______
Benzo (k) fluoranthene	______	Fluorene	______
Bis (2-chloroethoxy) Methane	______	Hexachlorobenzene	______
Bis (2-chloroethyl) ether	______	Hexachlorobutadiene	______
Bis (2-chloroisopropyl) ether	______	Hexachlorocyclopentadiene	______
Bis (2-ethyl hexyl) phthalate	______	Hexachloroethane	______
4 Bromophenyl phenyl ether	______	Indeno (1,2,3-cd) Pyrene	______
Butyl Benzyl Phthalate	______	Isophorone	______
2-Chloronaphthalene	______	Naphthalene	______
4-Chlorophenyl phenyl ether	______	Nitrobenzene	______
Chrysene	______	N-Nitrosodimethylamine	______
Dibenzo(a,h) Anthracene	______	N-Nitroso di-N-propylamine	______
1,2 Dichlorobenzene	______	N-Nitrosodiphenylamine	______
1,3 Dichlorobenzene	______	Phenanthrene	______
1,4 Dichlorobenzene	______	Pyrene	______
3,3' Dichlorobenzidine	______	1,2,4 Trichlorobenzene	______
		Other	______

GC/MS FRACTION

PESTICIDES

Units of Concentration μg/L _____

mg/L _____

Other _____

Aldrin	
a-BHC	
B-BHC	
γ-BHC	
δ-BHC	
Chlordane	
4,4' DDT	
4,4' DDE	
4,4' DDD	
Dieldrin	
α-Endosulfan	
B-Endosulfan	
Endosulfan	
Endrin	
Endrin Aldehyde	
Heptachlor	
Heptachlor Epoxide	
PCB-1242	
PCB-1254	
PCB-1221	

PCB 1232	
PCB 1248	
PCB 1260	
PCB 1016	
Toxaphene	
Other	

PRIORITY POLLUTANT METALS

Antimony

Arsenic

Beryllium

Cadmium

Chromium

Copper

Lead

Mercury

Nickel

Selenium

Silver

Thallium

Zinc

WESTON

DESIGNERS CONSULTANTS

APPENDIX E

ANALYSIS OF PUMP TEST AND SLUG TEST DATA

RUN

OBSERVATION WELL: P4

TEST START: 11:30,4/28.

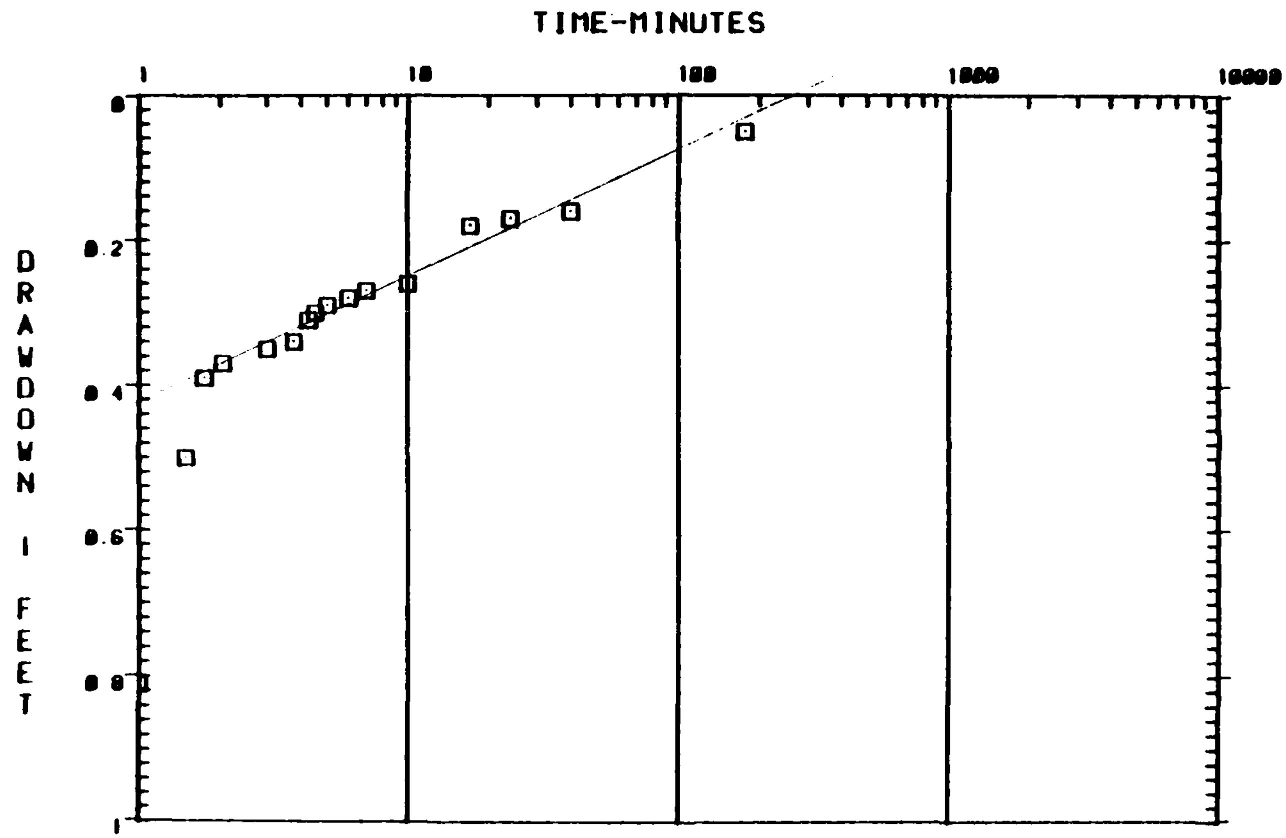
TEST END: 14:00,4/28

PUMPING WELL: GRIFFISS AFB, LANDFILL 1, PUMP TEST RECOVERY, 4/28/82.

R(FEET): 0 Q(GPM): 10
STATIC LEVEL DEPTH(FEET): 25.38 TIME/DATE: 10:00,4/28

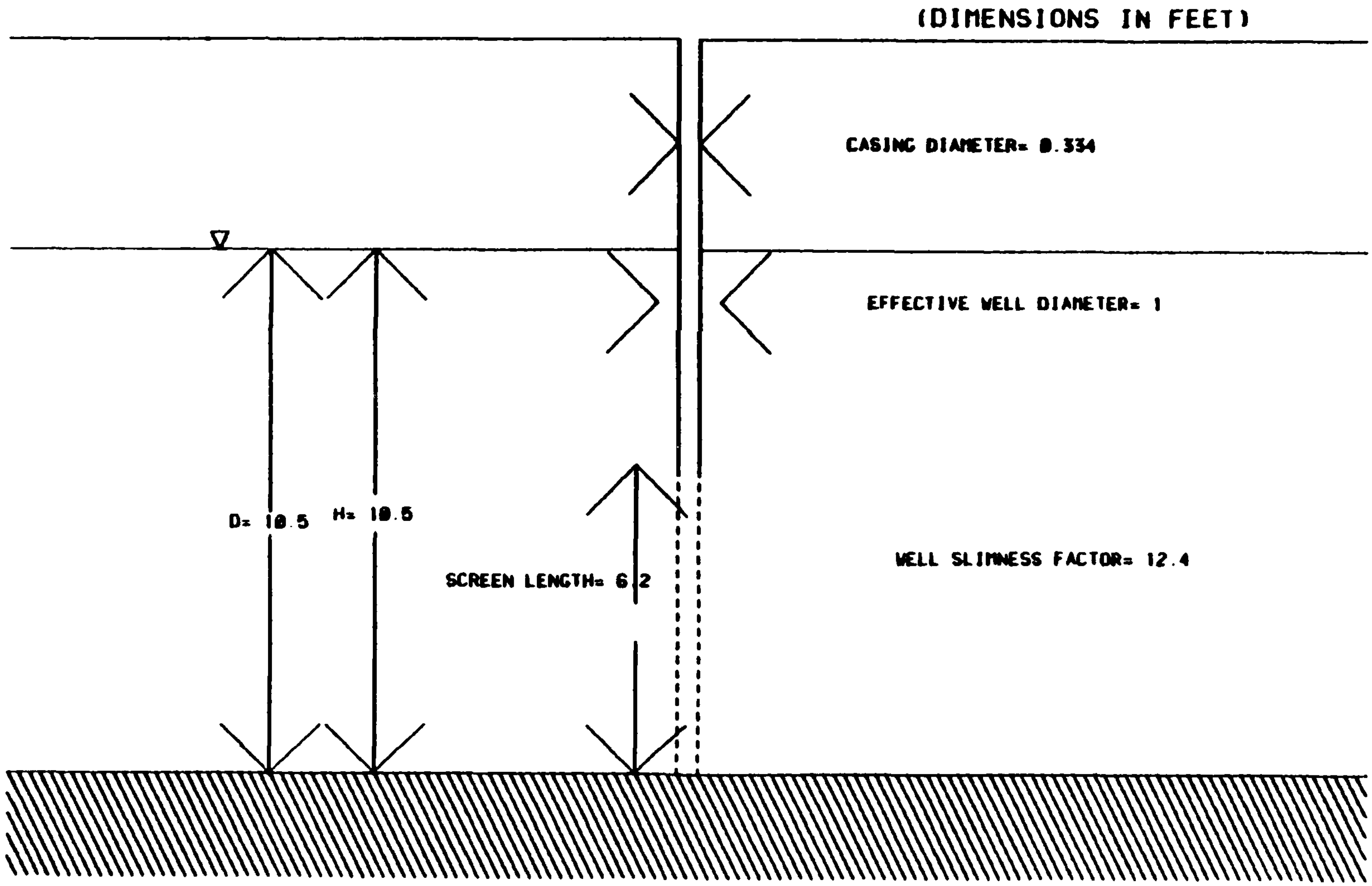
TIME	ELAPSED TIME MINUTES	DTW	S
11:31	1.0	26.19	0.81
11:31	1.5	25.88	0.50
11:32	1.8	25.77	0.39
11:32	2.1	25.75	0.37
11:33	3.0	25.73	0.35
11:34	3.8	25.72	0.34
11:34	4.3	25.69	0.31
11:34	4.5	25.68	0.30
11:35	5.0	25.67	0.29
11:36	6.0	25.66	0.28
11:37	7.0	25.65	0.27
11:40	10.0	25.64	0.26

11:47	17.0	25.56	0.18
11:54	24.0	25.55	0.17
12:10	40.0	25.54	0.16
14:25	175.0	25.43	0.05



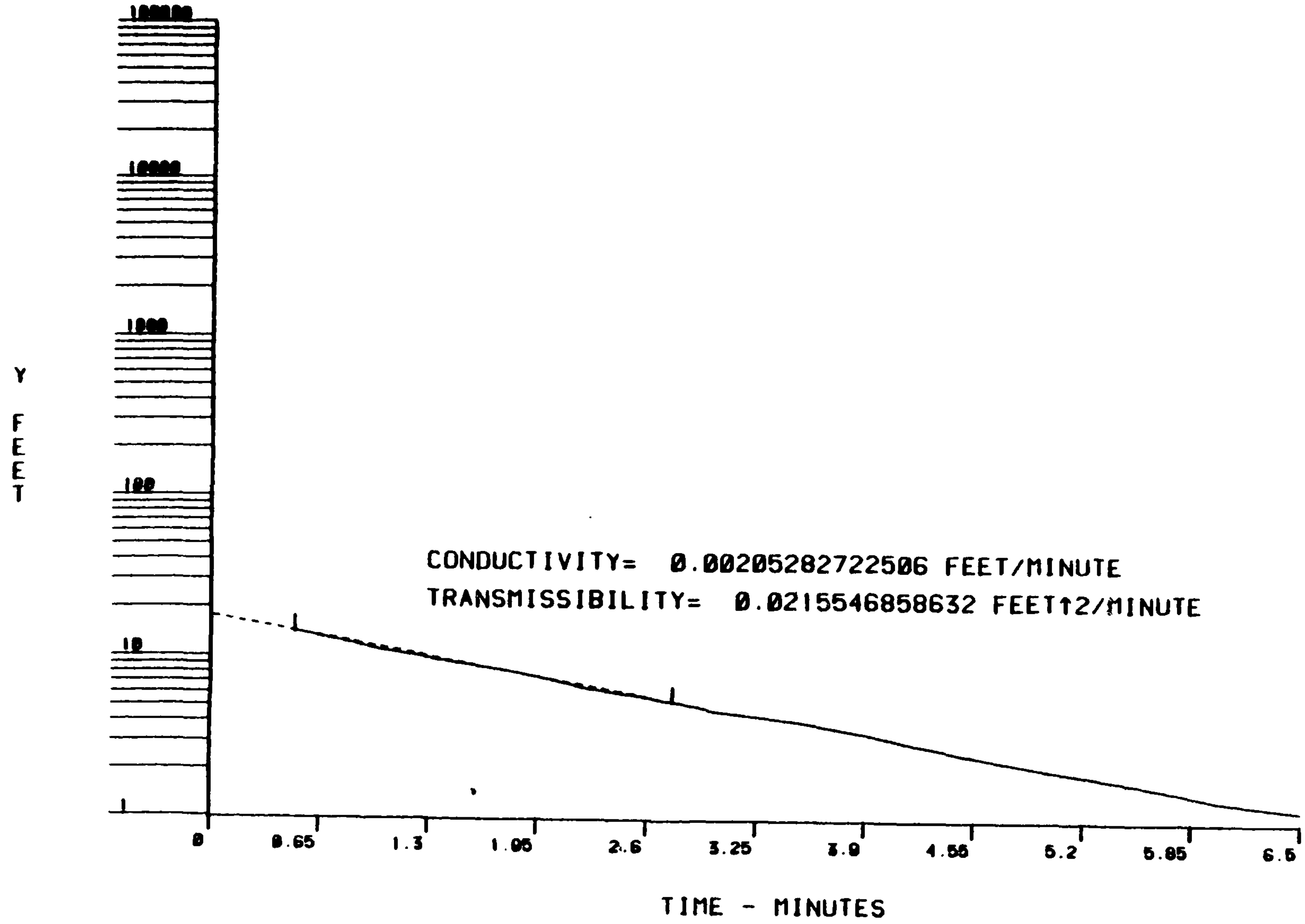
PROJECT: RUN
PUMP WELL: GRIFFISS AFB, LANDFILL 1, PUMP TEST RECOVERY, 4/28/82.
OBSERVATION WELL: P4
PUMPING RATE (GPM): 10

GRIFFISS AFB. SLUG-RECOVERY TEST, W5, 4/28/82.



GRIFFISS AFB. SLUG-RECOVERY TEST, W5, 4/28/82.

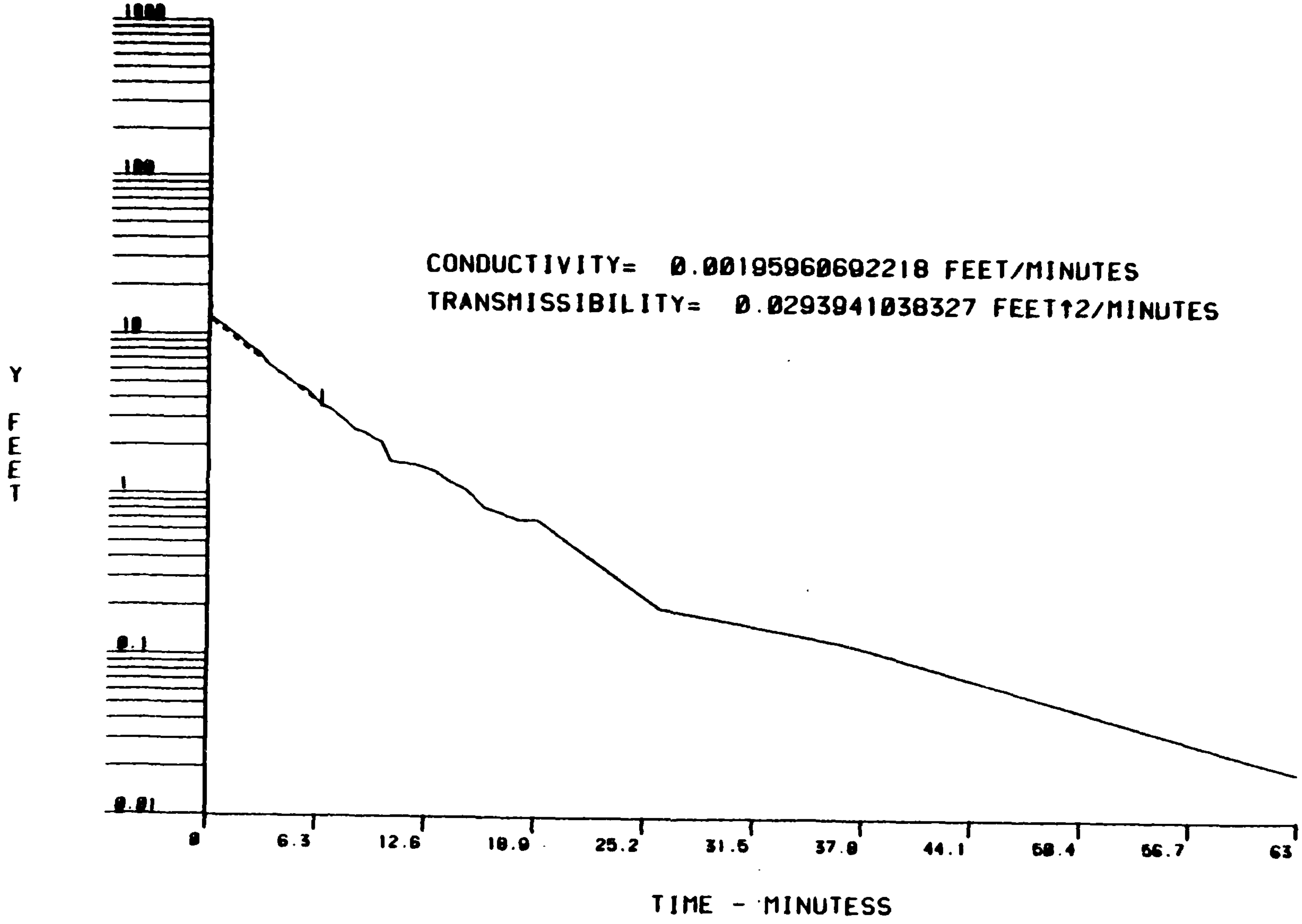
	'Y' READINGS	TIME (MINUTE)
1	14.45	0.5
2	11.29	1
3	10.21	1.25
4	9.25	1.5
5	8.46	1.75
6	7.54	2
7	6.54	2.25
8	5.5	2.75
9	4.79	3
10	4.15	3.5
11	3.33	4
12	2.6	4.5
13	2.1	5
14	1.75	5.5
15	1.38	6
16	1.19	6.5



GRIFFISS AFB. SLUG-RECOVERY TEST, W5, 4/28/82.

GRIFFISS AFB. SLUG-RECOVERY TEST. P3. 4/20/82.

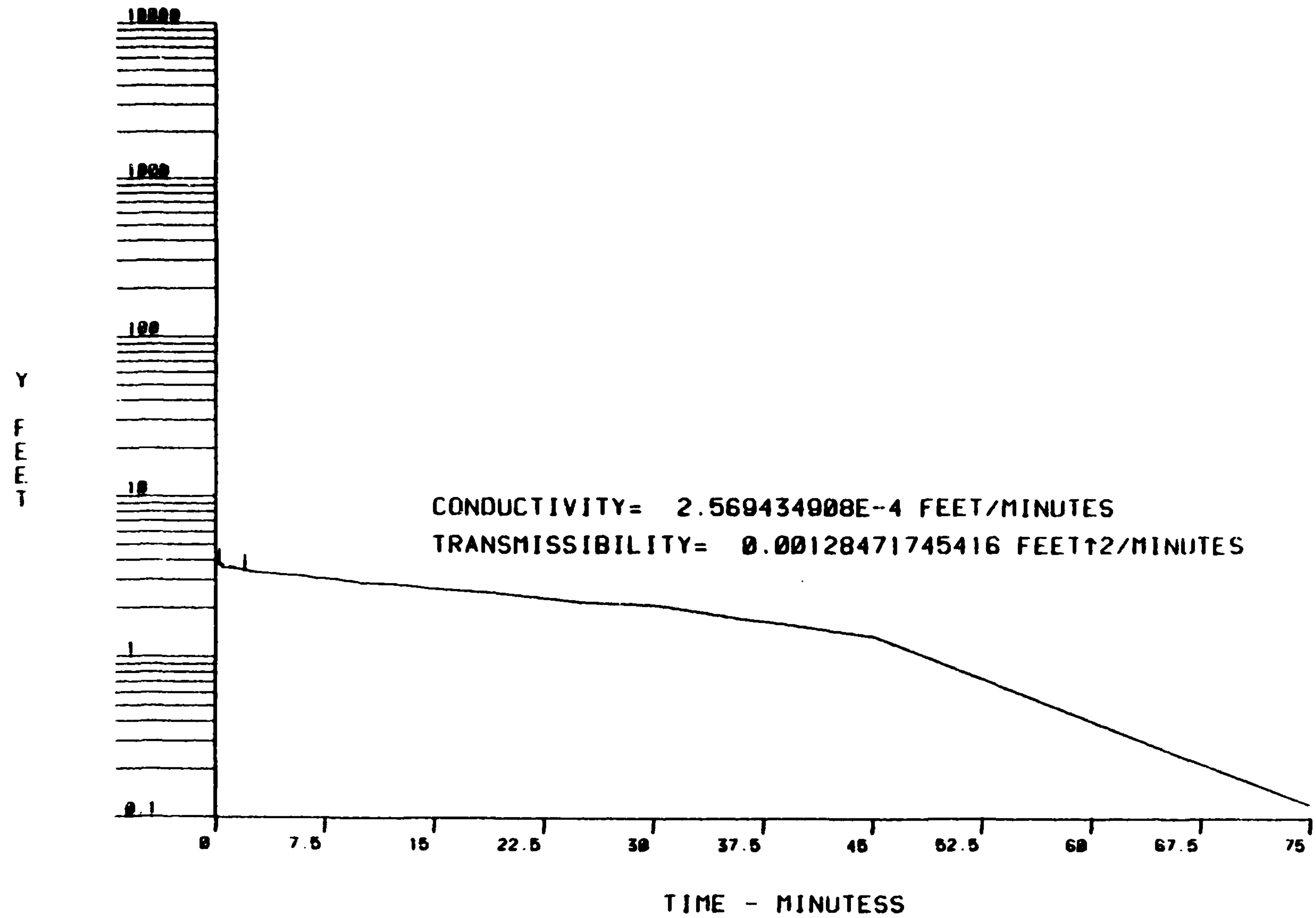
	'Y' READINGS	TIME (SECONDS)
1	12.37	0
2	12.20	0.25
3	10.70	1
4	9	2
5	8.12	2.5
6	7.45	3
7	6.37	3.5
8	5.87	4
9	5.37	4.5
10	4.87	5
11	4.62	5.5
12	4.12	6
13	3.62	6.5
14	3.41	7
15	3.12	7.5
16	2.83	8
17	2.53	8.5
18	2.45	9
19	2.25	9.5
20	2.12	10
21	1.62	10.5
22	1.58	11
23	1.54	12
24	1.42	13
25	1.21	14
26	1.06	15
27	0.83	16
28	0.7	18
29	0.7	19
30	0.2	26
31	0.12	37
32	0.02	63



GRIFFISS AFB. SLUG-RECOVERY TEST, P3, 4/28/82.

GRIFFISS AFB, RECOVERY TEST, WELL P-2,4/29/82.

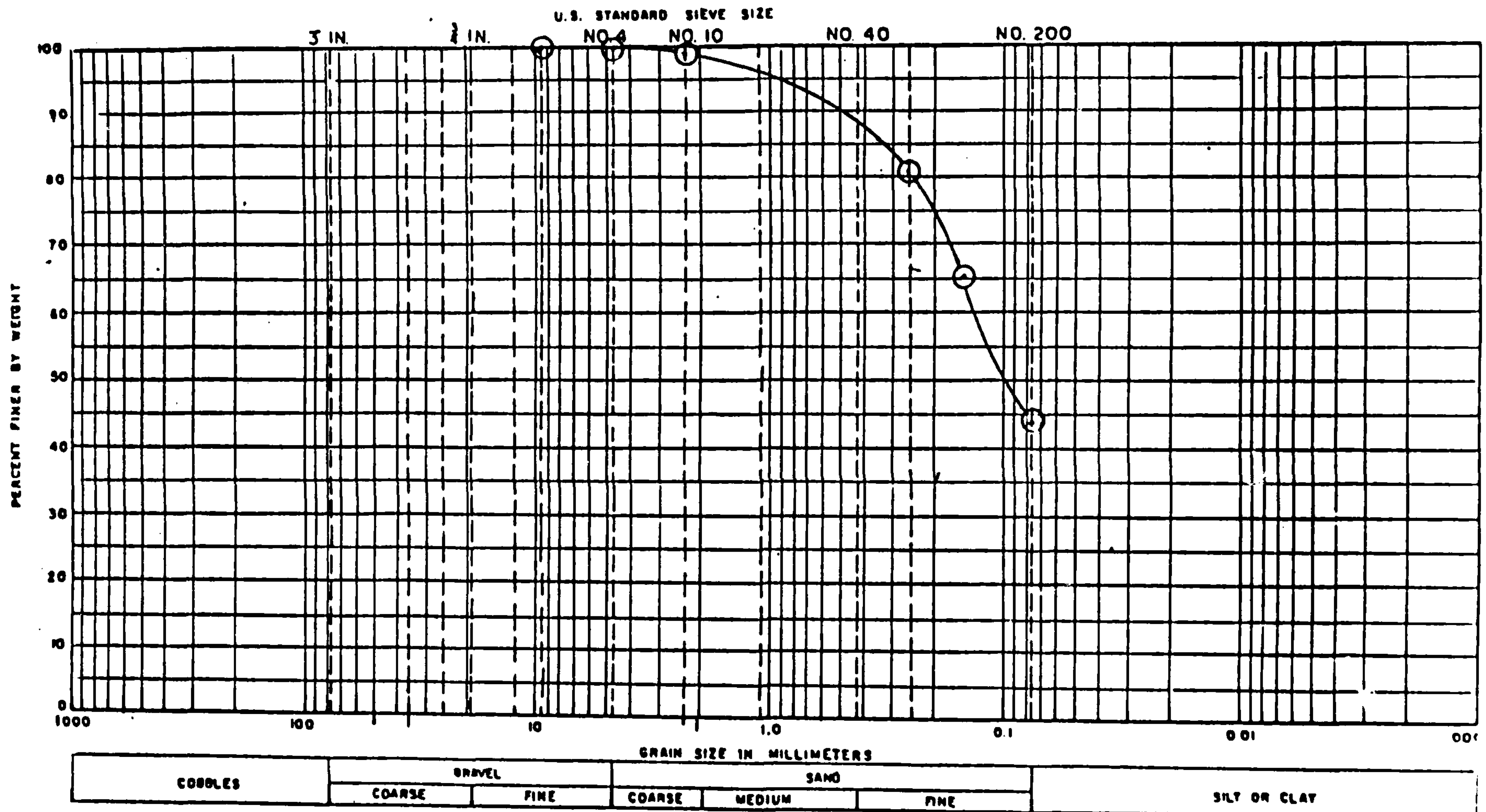
	'Y' READINGS	TIME (MINUTE)
1	2.66	0
2	2.56	0.25
3	2.46	0.5
4	2.42	0.75
5	2.42	1
6	2.41	1.25
7	2.4	1.5
8	2.35	2
9	2.23	2.5
10	2.2	3
11	2.1	4.5
12	2.09	5
13	2.04	6
14	1.94	7
15	1.92	8
16	1.73	10
17	1.69	12
18	1.5	15
19	1.31	20
20	1.06	25
21	0.95	30
22	0.65	35
23	0.21	45



GRIFFISS AFB, LANDFILL 1, RECOVERY TEST, P2.

APPENDIX F

GRAIN SIZE ANALYSIS DATA

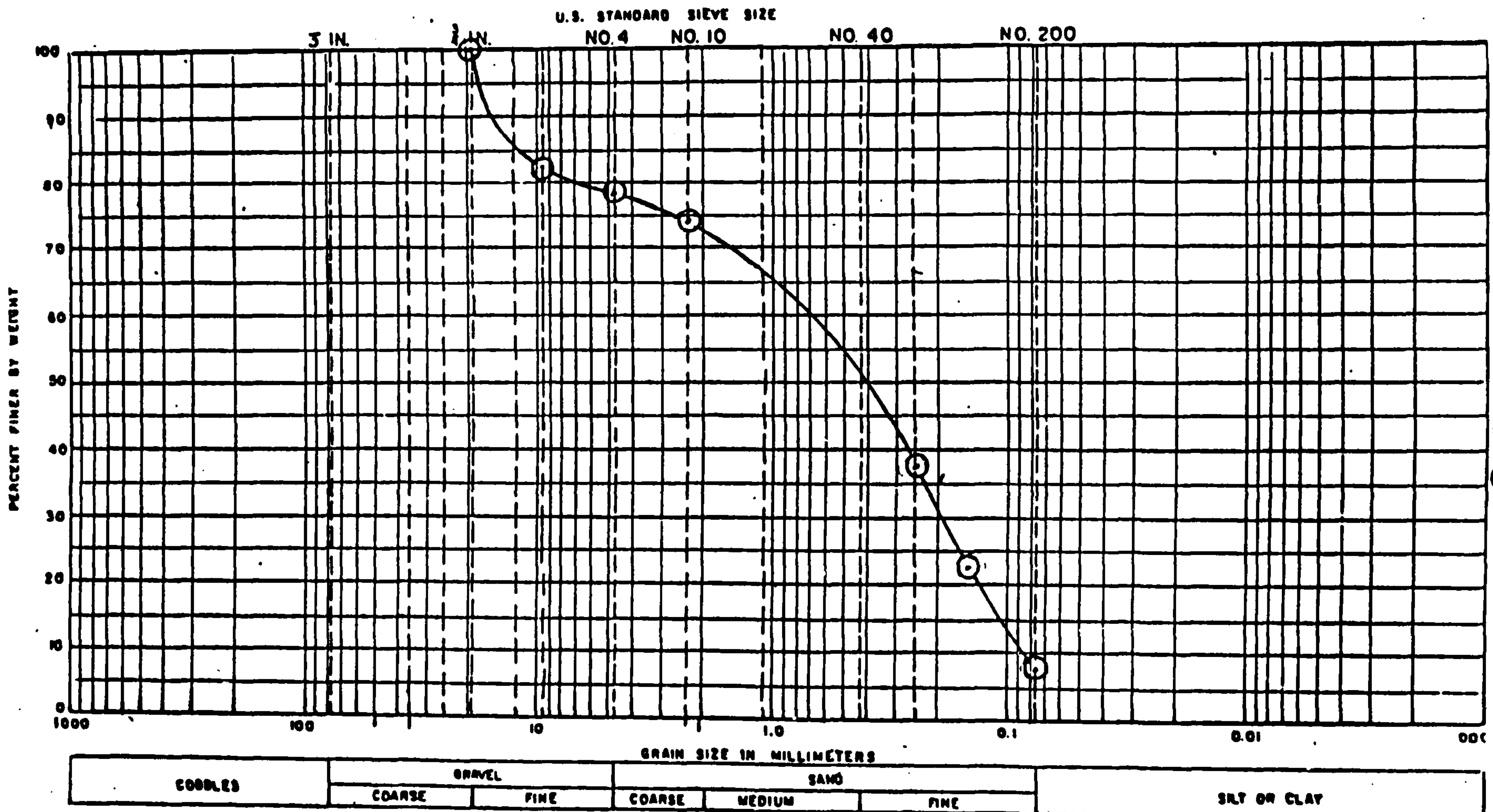


Boring No.	Sample No.	Elev. or Depth	Classification	NMC	L.L.	P.L.	P.I.
W-6,S-2	15666-8	5-6.5					

Project 15666-479

Area Griffis AFB, Rome, N.Y.

Date 6/23/82

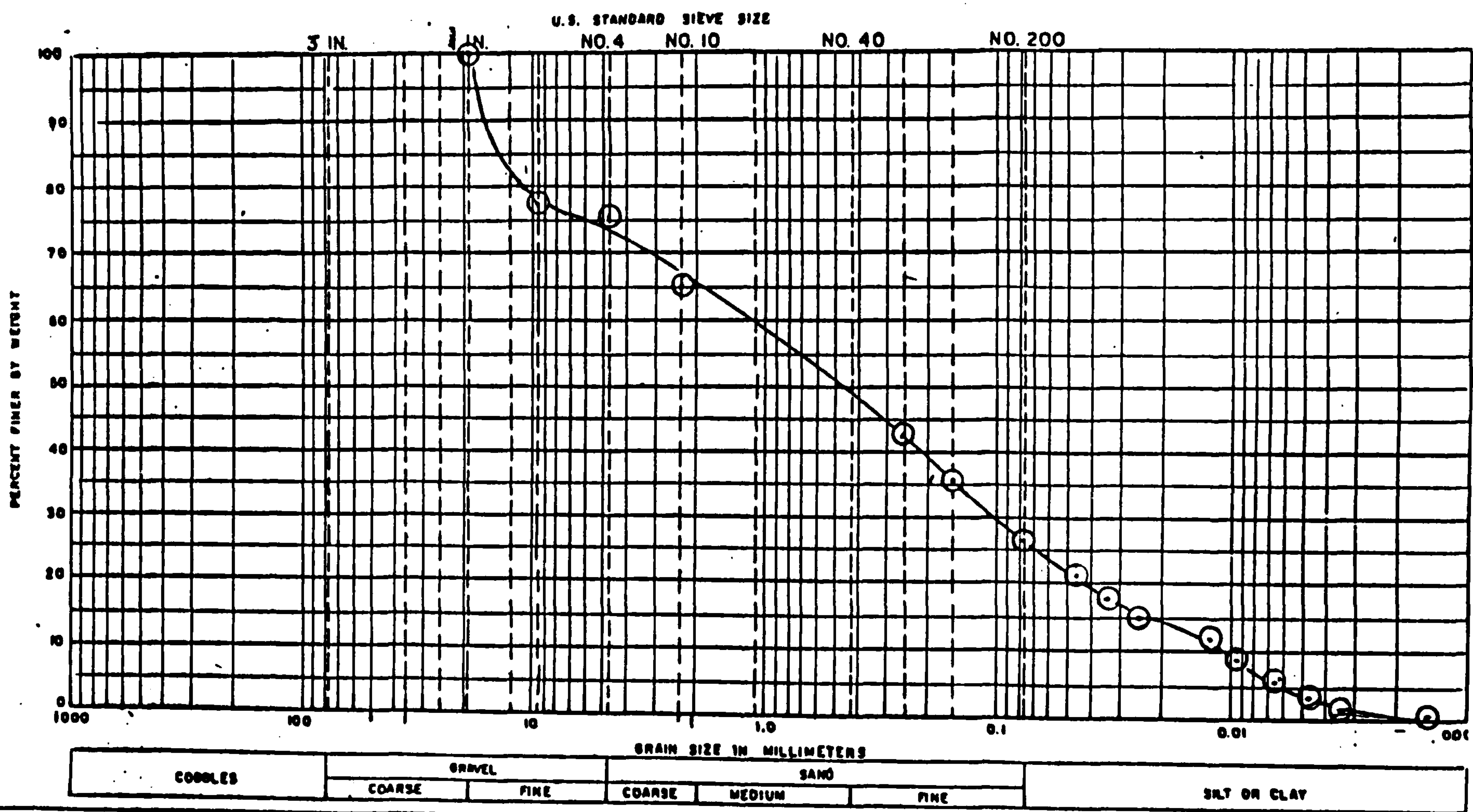


Boring No.	Sample No.	Elev. or Depth	Classification	NMC	L.L.	P.L.	P.I.
P-1, S-2	15666-1	5-6.5	C_u = 8.0				

Project 15666-479

Area Griffis AFB, Rome, N.Y.

Date 6/23/82

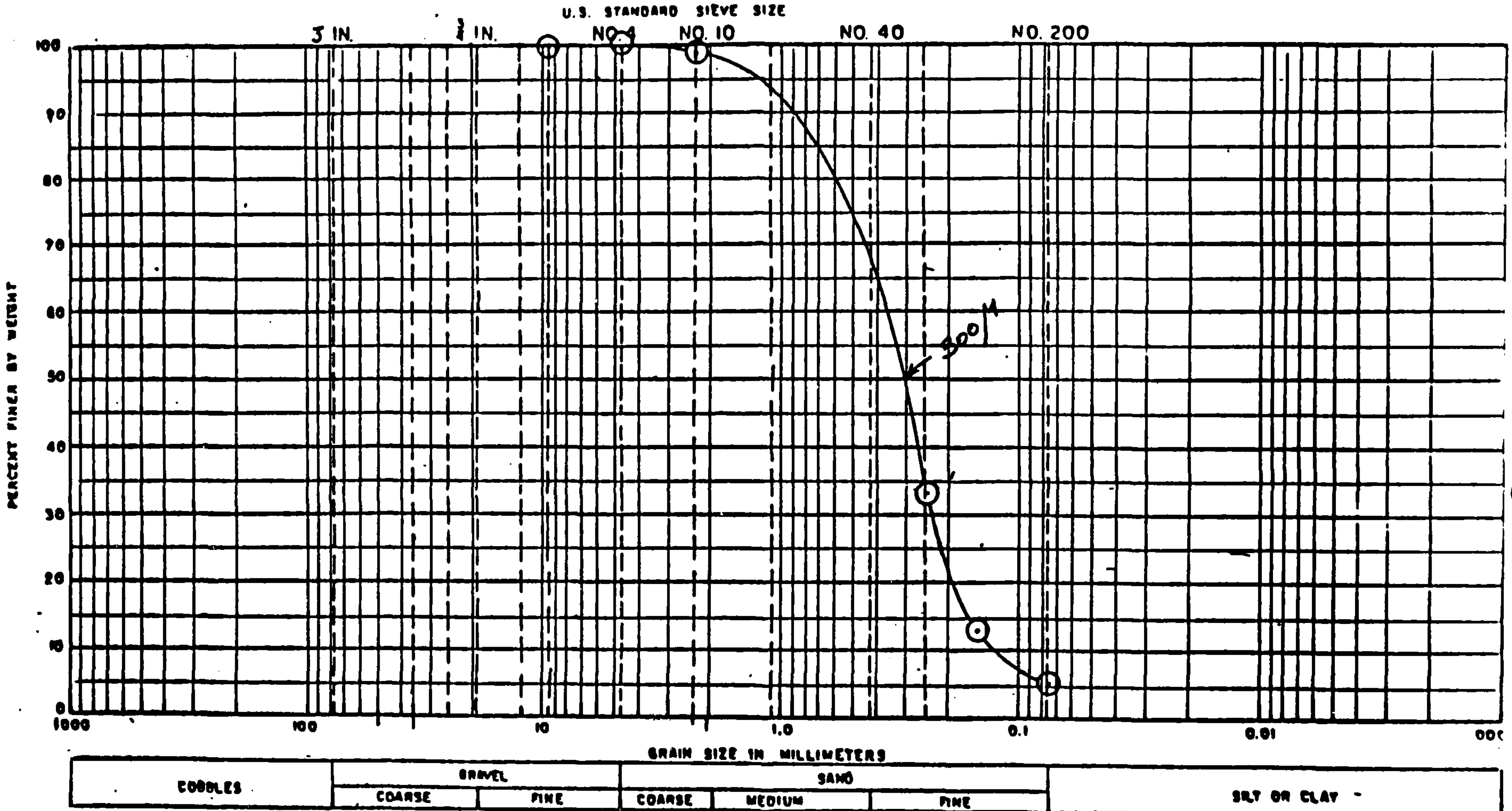


Boring No.	Sample No.	Elev. or Depth	Classification	NMC	L.L.	P.L.	P.I.
P-1, S-3	15666-2	10-11.5					

Project 15666-479

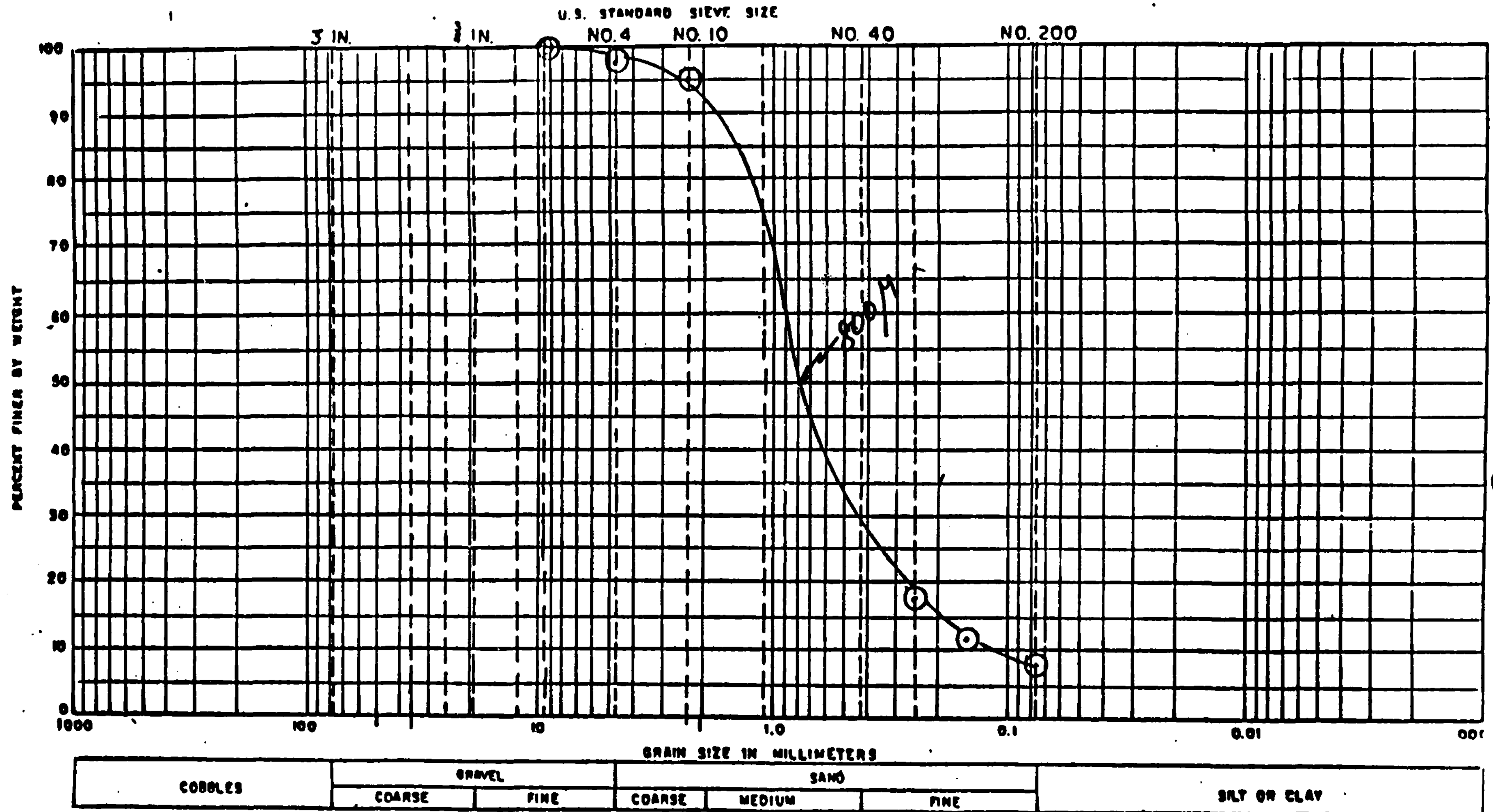
Area Griffis AFB, Rome, N.Y.

Date 6/23/82



Boring No.	Sample No.	Elev. or Depth	Classification	NMC	L.L.	P.L.	P.I.	
P-2,S-2	15666-3	10-11.5	C_{u} = 3.1					Project 15666-479
								Area Griffis AFB, Rome, N.Y.
								Date 6/23/82

WESTON



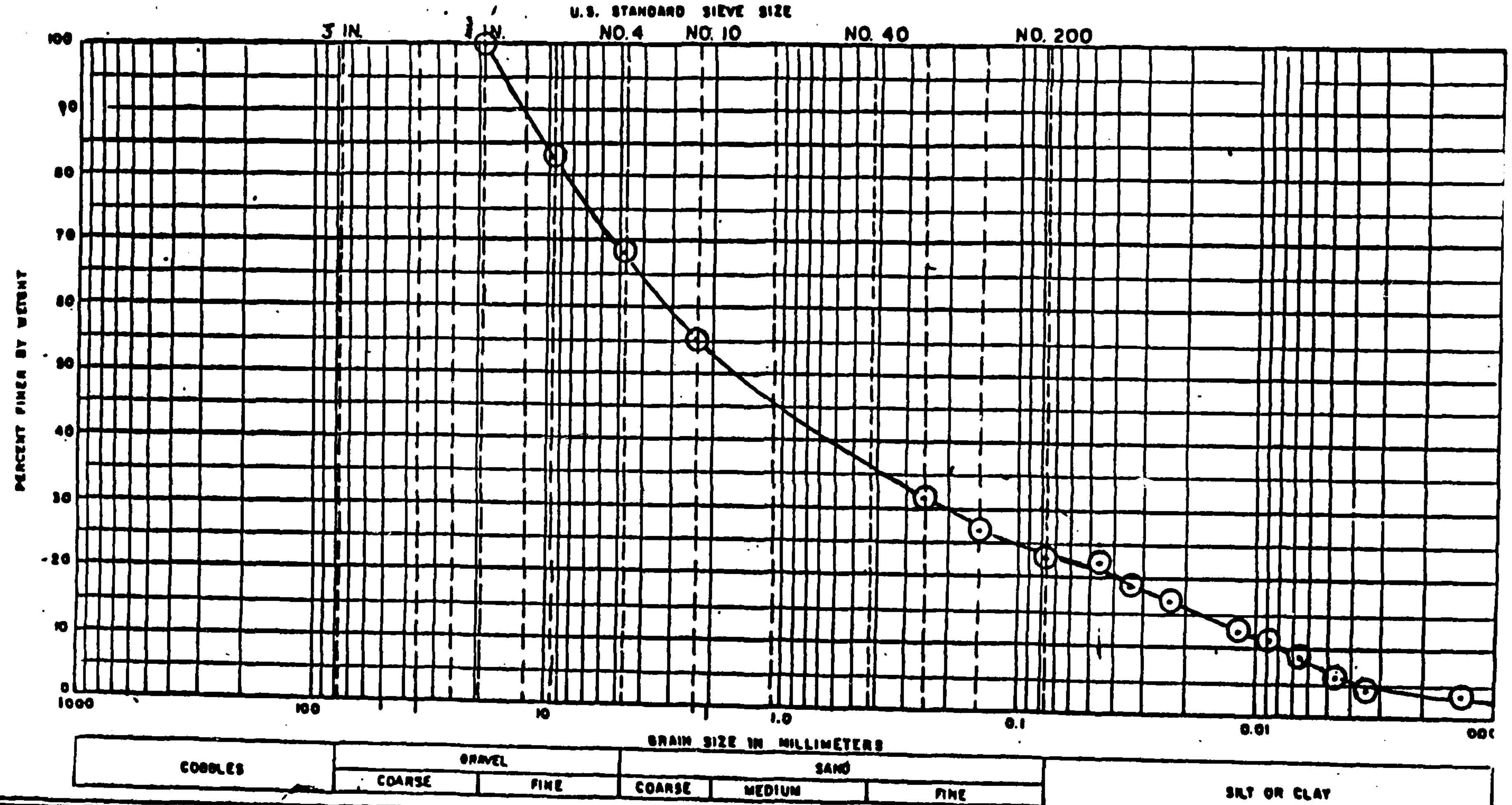
Boring No.	Sample No.	Elev. or Depth	Classification	NMC	L.L.	P.L.	P.I.
P-3,S-3	15666-4	10-10.5	C_u = 8.6				

Project 15666-479

Area Griffis AFB, Rome, N.Y.

Date 6/23/82

WESTON



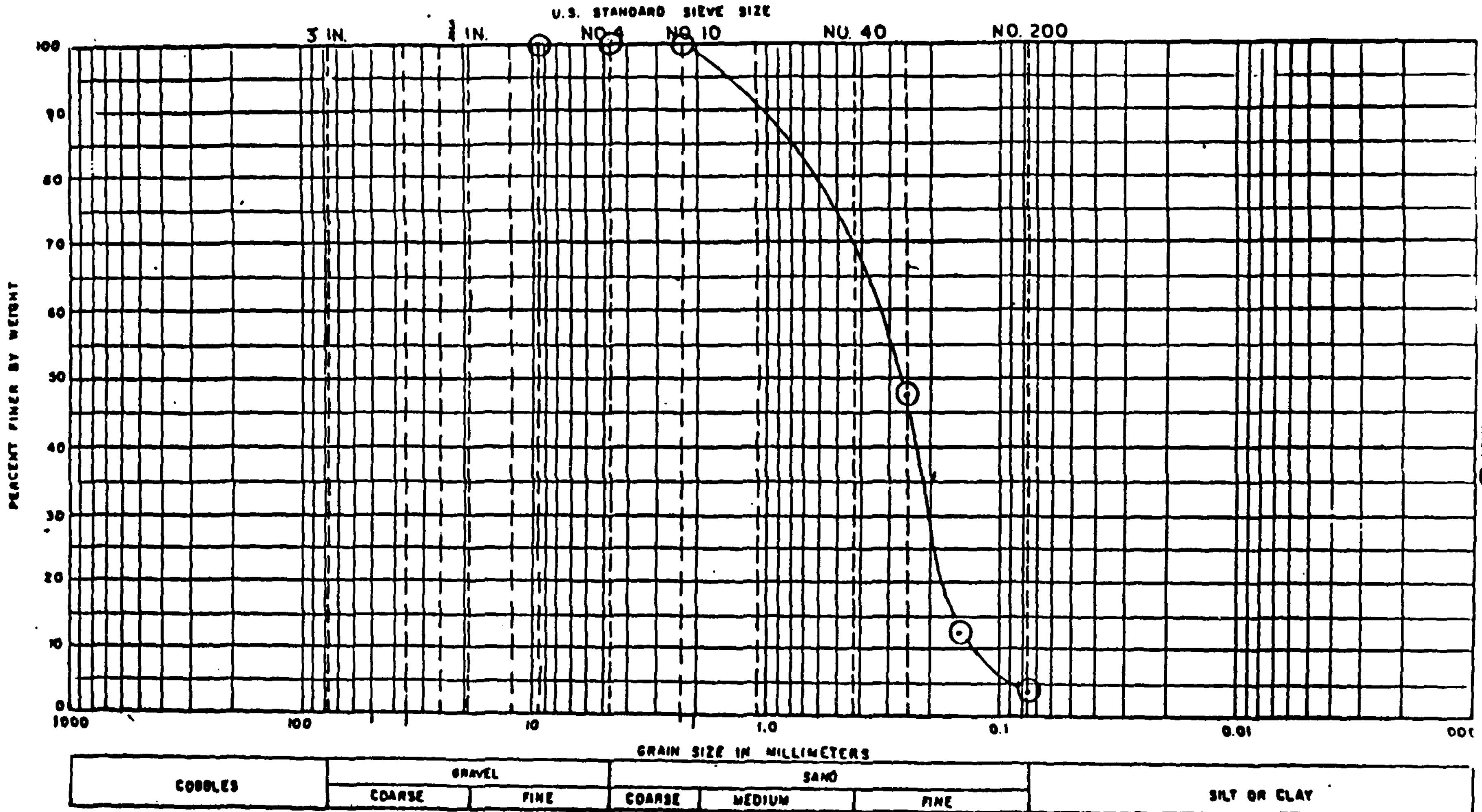
Boring No.	Sample No.	Elev. or Depth	Classification	NMC	L.L.	P.L.	P.I.
P-3,S-3A	15666-5	10.5-11					

Project 15666-479

Area Griffis AFB, Rome, N.Y.

Date 6/22/82

WESTON

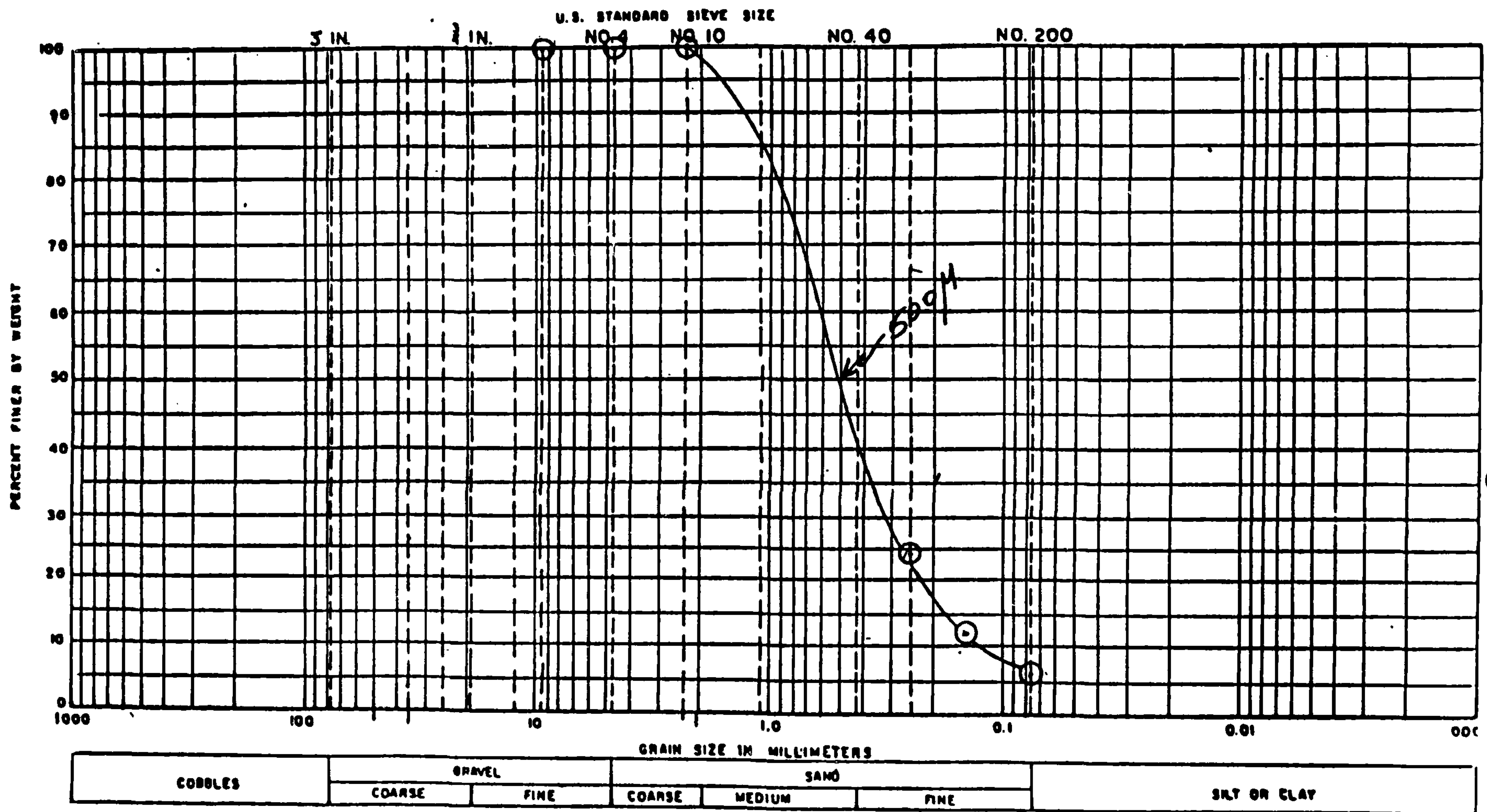


Boring No.	Sample No.	Elev. or Depth	Classification	NMC	L.L.	P.L.	P.I.
P-4, S-3	15666-6	10-11.5	C_u = 2.9				

Project 15666-479

Area Griffis AFB, Rome, N.Y.

Date 6/23/82



Boring No.	Sample No.	Elev. or Depth	Classification	NMC	L.L.	P.L.	P.I.
P-4, S-7	15666-7	30-31.5	$C_u = 5.5$				

Project 15666-479

Area Griffis AFB, Rome, N.Y.

Date 6/23/82

APPENDIX G

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
SAFE DRINKING WATER STANDARDS

Table G-1

Total Interim Primary Drinking Water Standards
Maximum Contaminant Levels (MCL)

Contaminant	MCL mg/l
Inorganic	
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.0
Selenium	0.01
Silver	0.05
Turbidity	1 unit
Fluoride	1.4 - 2.4
Organic	
a. Chlorinated Hydrocarbons	
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
b. Chlorophenoxys	
2,4-D	0.1
2,4,5-TP Silvex	0.01
c. Trihalomethane	0.1 (proposed)
Microbiological Contaminant	One coliform bacterium per 100 ml as the arithmetic mean of all samples per month

WESTON

Table G-2

National Secondary Drinking Water Standards
Secondary Maximum Contaminant Levels

Contaminant	MCL
Chloride	250 mg/L
Color	15 color units
Copper	1 mg/L
Corrosivity	Non-corrosive
Foaming Agents	0.5 mg/L
Hydrogen Sulfide	0.5 mg/L
Iron	0.3 mg/l
Manganese	0.05 mg/l
Odor	3 threshold odor number
pH	6.5 - 8.5
Sulfate	250 mg/l
TDS	500 mg/l
Zinc	5 mg/l

AD-A125 958 INSTALLATION RESTORATION PROGRAM PHASE II PROBLEM CONFIRMATION AND QUANTI..(U) WESTON (ROY F) INC WEST CHESTER PA DEC 82 F33615-80-D-4006 3/3

UNCLASSIFIED F/G 13/2 NL

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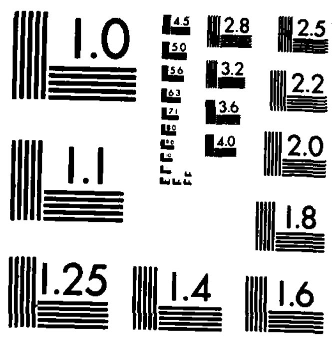

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

APPENDIX H

STREAM FLOW MEASUREMENT DATA

Stream Flow Measurements by Symmation of Cross-Section Increments

$$q_i = \frac{B_i D_i (v(02D_i) + v(08D_i)}{2}$$

$$Q = \mathop{}_{i=1}^{n} \frac{B_i D_i \; (v(0.2D_i) + v(0.8D_i)}{2}$$

q_i = Instantaneous flow of cross-section segment i.

Q = Instantaneous flow at stream cross-section

$v(o.2D_i)$ = Stream velocity at a depth of 0.2 x total depth.

$v(o.8D_i)$ = Stream velocity at a depth of 0.8 x total depth.

B_i = Width of cross-section segment i.

D_i = Measured depth of cross-section segment i.

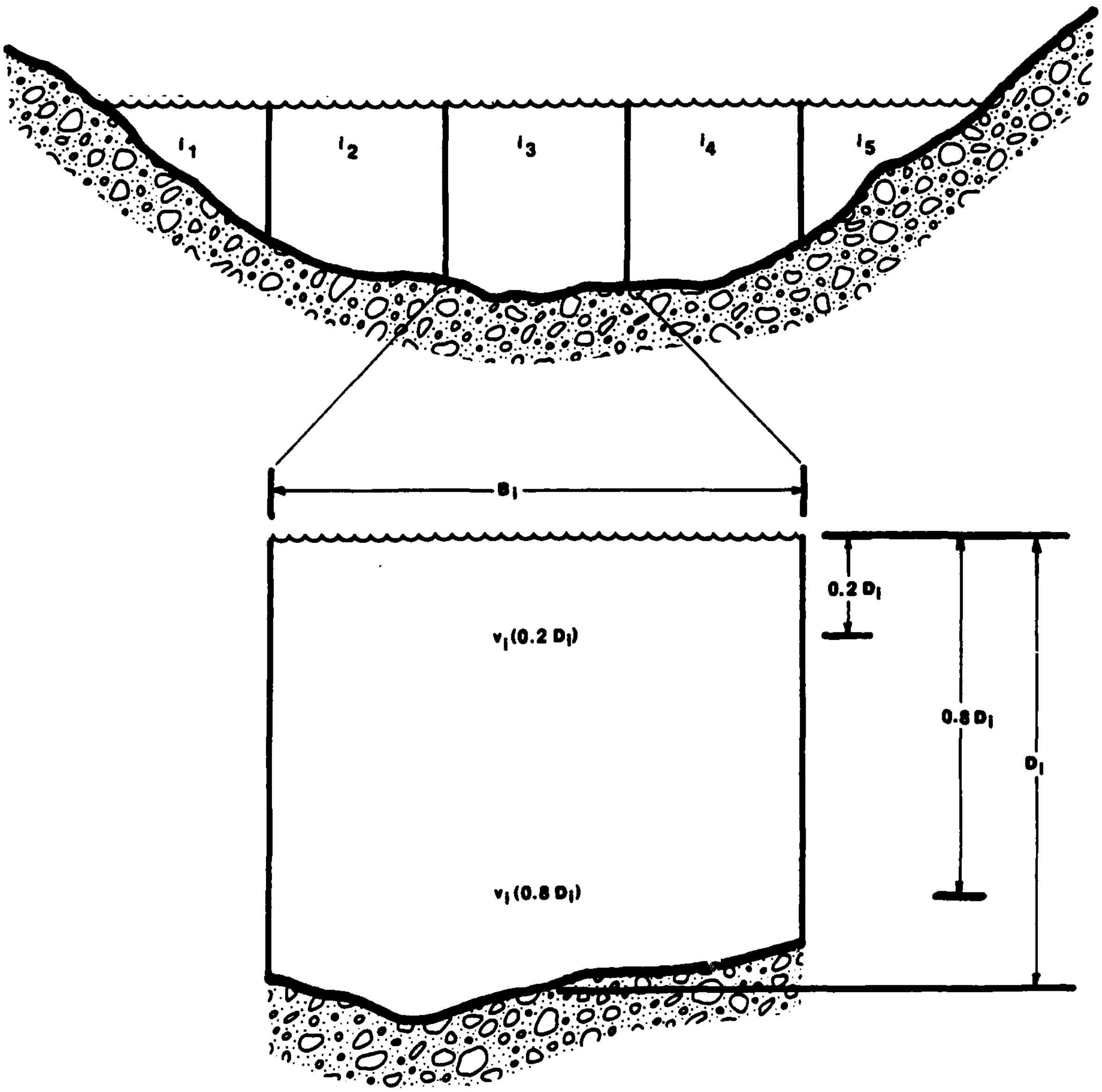

Figure H-1: Schematic of Stream Flow Measurements

WESTON

Location 1, Upstream from Landfill 1 Leachate Seep, Approximately 50 feet downstream from Bridge

Date: 4-27-82 B_i = 1.0 feet

i	$v(0.2D_i)$ (ft./sec.)	$v(0.8D_i)$ (ft./sec.)	Depth (feet)	v Avg. (ft./sec.)	q_i ($ft.^3$/sec.)
1	0.1	0.1	0.71	0.1	0.07
2	0.2	0.3	0.98	0.3	0.29
3	0.5	0.3	1.12	0.4	0.45
4	0.07	0.06	1.38	0.7	0.97
5	0.6	0.6	1.10	0.6	0.66
6	0.6	0.5	1.06	0.6	0.64
7	0.7	0.6	0.90	0.7	0.63
8	0.3	0.1	0.73	0.2	0.15
9	0.3	0.2	0.54	0.3	0.16
10	0.4	0.3	0.54	0.4	0.22
11	0.3*	--	0.44	0.3	0.13
12	0.2*	--	0.25	0.2	0.05

Q = 4.4 cfs
= 2.85 mgd

*Indicates measured at 0.5x the total depth.

Location 2, Immediately Downstream
From Landfill 1 Leachate Seep

Date: 4/27/82 B_i = 1.0 feet

i	$V(0.2D_i)$ (ft. sec)	$v(0.8D_i)$ (ft./sec.)	Depth (feet)	v Avg. (ft./sec.)	q_i (ft.^{3}/sec.)
1	1.3	1.3	0.33	1.3	0.43
2	1.6	1.6	0.48	1.6	0.77
3	1.6	1.6	0.65	1.6	1.04
4	2.1	2.1	0.66	2.1	1.39
5	0.8	0.8	0.38	0.8	0.30
6	0.1	0.1	0.08	0.1	0.01

Q = 3.9 ft.^{3}/sec.
= 2.53 mgd

WESTON

Location 3, Southeast End of Main Landing Strip,
Near Stream Exit from Base, Adjacent to the Family Center

Date: 4/27/82 B_i = 1.0 foot

i	$v(0.2D_i)$ (ft/sec.)	$v(0.8D_i)$ (ft./sec.)	Depth (feet)	v Avg. (ft./sec.)	q_i (ft.^{3}/sec.)
1	0.1	0.2	0.45	0.2	0.09
2	0.4	0.3	0.88	0.4	0.35
3	0.4	0.4	0.92	0.4	0.37
4	0.5	0.4	0.98	0.5	0.49
5	0.5	0.5	0.90	0.5	0.45
6	0.6	0.4	0.92	0.5	0.46
7	0.6	0.4	0.94	0.5	0.47
8	0.6	0.6	0.94	0.6	0.56
9	0.6	0.5	0.96	0.6	0.58
10	0.6	0.5	0.96	0.6	0.58
11	0.6	0.4	1.05	0.5	0.53
12	0.5	0.2	1.10	0.4	0.44
13	0.5	0.2	1.08	0.4	0.43

Q = 5.8 cfs
= 3.76 mgd

APPENDIX I

EXERPTS FROM NEW YORK STATE REGULATIONS GOVERNING LANDFILLS

not exceeding five gallons per day, from any individual; provided, however, that the service establishment's used engine lubricating oil retention facility is not temporarily filled to capacity.

(c) Requirements for hazardous waste management facilities.

In addition to the general requirements contained in Subdivision 360.8(a) of this Part, the requirements of this subdivision shall apply to facilities not exempted in Subdivision 360.1(f) that treat, store or dispose of hazardous wastes as defined in Part 366 of this Title, other than those facilities receiving only hazardous waste from generators exempted by Subparagraphs 365.1 (e)(1)(i) and (iv) of this Title. Where conflicting requirements exist, the more stringent shall apply.

(1) General facility standards.

The regulations in this Paragraph apply to the owners and operators of all hazardous waste facilities subject to this Subdivision.

(i) Facility ownership transfer.

(a) The ownership or operation of a facility during its operating life or of a disposal facility during the period of post-closure care shall be transferable only upon prior written approval of the Department.

(b) Before transferring ownership or operation of a facility during its operating life, or of a disposal facility during the post-closure care period, the owner or operator must notify the new owner or operator in writing of the requirements of this Part.

(ii) General waste analysis.

(a) (1) Before an owner or operator treats, stores, or disposes of any hazardous waste, he must obtain a detailed chemical and physical analysis of a representative sample of the waste. At a minimum, this analysis must contain all the information which must be known to treat, store, or dispose of the waste in accordance with the requirements of this Part.

(2) The analysis may include data developed under Part 366 of this Title, and existing published or documented data on the hazardous waste or on waste generated from similar processes.

(3) The analysis must be repeated as necessary to ensure that it is accurate and up to date. At a minimum, the analysis must be repeated:

360.8 (c)(4)(iii)

this report. The annual report must cover facility activities during the previous calendar year and must include the following information:

(a) The EPA identification number, name and address of the facility;

(b) The calendar year covered by the report;

(c) For off-site facilities, the EPA identification number of each hazardous waste generator from which the facility received a hazardous waste during the year; for imported shipments, the report must give the name and address of the foreign generator;

(d) A description and the quantity of each hazardous waste the facility received during the year. For off-site facilities, this information must be listed by the EPA identification number of each generator;

(e) The method of treatment, storage, or disposal for each hazardous waste;

(f) Monitoring data under Items 360.8(c)(5)(v)(a)(2)(ii) and (iii) and Subclause (b)(2), where required;

(g) The most recent closure cost estimate under Subparagraph 360.8(c)(7)(i) and, for disposal facilities, the most recent post-closure cost estimate under Subparagraph 360.8(c)(7)(ii); and

(h) The certification signed by the owner or operator of the facility or his authorized representative.

(iv) Additional reports.

In addition to submitting the annual report and un-manifested waste reports described in Subparagraph 360.8(c)(4)(iii), Paragraphs 365.4(c)(2), and 365.7(c)(2), of this Title, the owner or operator must also report to the Commissioner:

(a) Releases, fires and explosions as specified in Clause 360.8(c)(3)(vi)(j);

(b) Groundwater contamination and monitoring data as specified in Subparagraphs 360.8(c)(5)(iv) and 360.8(c)(5)(v); and

(c) Facility closure as specified in Subparagraph 360.8(c)(6)(v).

(5) Groundwater monitoring.

(i) Applicability.

(a) By the effective date of these regulations the owner or operator of a surface impoundment, secure landburial facility, or land treatment facility subject to this Subdivision must implement a groundwater monitoring program capable of determining the facility's impact on the quality of groundwater in the uppermost aquifer underlying the facility, except as Clause (c) of this Subparagraph provides otherwise. The Commissioner may require facilities other than surface impoundments, secure landburial facilities, and land treatment

facilities to comply with the provisions of this paragraph and may require additional water bearing zones to be monitored.

(b) Except as Clauses (c) and (d) of this Paragraph provide otherwise, the owner or operator must install, operate, and maintain a groundwater monitoring system which meets the requirements of Subparagraph 360.8(c)(5)(ii), and must comply with Subparagraphs 360.8(c)(5)(iii) through 360.8(c)(5)(v). This groundwater monitoring program must be carried out during the active life of the facility, and for disposal facilities, during the post-closure care period as well.

(c) The Department may waive all or part of the groundwater monitoring requirements of this Paragraph if the owner or operator can demonstrate that there is a low potential for migration of hazardous waste or hazardous waste constituents from the facility via the uppermost aquifer to water supply wells (domestic, industrial or agricultural) or to surface water. This demonstration must be in writing and must be kept at the facility and submitted to the commissioner for approval. This demonstration must be certified by a qualified geologist or geotechnical engineer and must establish the following:

(1) The potential for migration of hazardous waste or hazardous waste constituents from the facility to the uppermost aquifers, by an evaluation of:

(i) A water balance of precipitation, evapotranspiration, runoff, and infiltration; and

(ii) Unsaturated zone characteristics (i.e., geologic materials, physical properties, and depth to ground water); and

(2) The potential for hazardous waste or hazardous waste constituents which enter the uppermost aquifers to migrate to a water supply well or surface water, by an evaluation of:

(i) Saturated zone characteristics (i.e., geologic materials, physical properties, and rate of groundwater flow); and

(ii) The proximity of the facility to water supply wells or surface water.

(d) If an owner or operator assumes (or knows) that groundwater monitoring of indicator parameters in accordance with Subparagraphs 360.8(c)(5)(ii) and 360.8(c)(5)(iii) would show statistically significant increases (or decreases in the case of pH) when evaluated under Clause 360.8(c)(5)(iv)(b), he may install, operate, and maintain an alternate groundwater monitoring system (other than the one described in Subparagraphs 360.8(c)(5)(ii) and 360.8(c)(5)(iii)). If the owner or operator decides to use an alternate groundwater monitoring system he must:

(1) By the effective date of these regu-

360.8 (c)(5)(i)(d)(1)

lations, submit to the Commissioner a specific plan, certified by a qualified geologist or geotechnical engineer, which satisfies the requirements of Subclause 360.8(c)(5)(iv)(d)(3), for an alternate groundwater monitoring system;

(2) By the effective date of these regulations, initiate the determinations specified in Subclause 360.8(c)(5)(iv)(d)(4);

(3) Prepare and subm[illegible] a written report in accordance with Subclause 360.8(c)(5)(iv)([illegible] (5);

(4) Continue to make [illegible]e determinations specified in Subclause 360.8(c)(5)(iv)(d)(4) [illegible] a quarterly basis until final closure of the facility; and

(5) Comply with the [illegible]dkeeping and reporting requirements in Clause 360.8(c)(5)([illegible]).

(ii) Groundwater monitoring system.

(a) A groundwater monitoring system must be capable of yielding groundwater samples for analysis and must consist of:

(1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield groundwater samples that are:

(i) Representative of background groundwater quality in the uppermost aquifer near the facility; and

(ii) Not affected by the facility; and

(2) Monitoring wells (at least three installed hydraulically downgradient (i.e., in the direction of decreasing static head) at the limit of the waste management area. Their number, locations, and depths must ensure that they immediately detect any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer.

(b) Separate monitoring systems for each waste management component of a facility are not required provided that provisions for sampling upgradient and downgradient water quality will detect any discharge from the waste management area. The Commissioner may require separate monitoring systems for separate waste management components.

(1) In the case of a facility consisting of only one surface impoundment, secure landburial facility, or land treatment area, the waste management area is described by the waste boundary (perimeter).

(2) In the case of a facility consisting of more than one surface impoundment, secure landburial facility, or land treatment area, the waste management area is described

by an imaginary boundary line which circumscribes the several waste management components.

(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the bore hole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the groundwater.

(iii) Sampling and analysis.

(a) The owner or operator must obtain and analyze samples from the installed groundwater monitoring system. The owner or operator must develop and follow a groundwater sampling and analysis plan, which shall be kept at the facility. The plan must include procedures and techniques for:

(1) Sample collection;

(2) Sample preservation and shipment;

(3) Analytical procedures; and

(4) Chain of custody control.

(b) The owner or operator must determine the concentration or value of the following parameters in groundwater samples in accordance with Clauses (c) and (d) of this Subparagraph:

(1) Parameters characterizing the suitability of the groundwater as a drinking water supply, as specified in Appendix III.

(2) Parameters establishing groundwater quality:

(i) Chloride;
(ii) Iron;
(iii) Manganese;
(iv) Phenols;
(v) Sodium; and
(vi) Sulfate; and

(3) Parameters used as indicators of groundwater contamination:

(i) pH;
(ii) Specific conductance;
(iii) Total organic carbon; and
(iv) Total organic halogen.

(c) (1) For all monitoring wells, the owner or operator must establish initial background concentrations or values of all parameters specified in Clause (b) of this Subparagraph. The owner or operator must do this quarterly for one year.

(2) For each of the indicator parameters specified in Subclause (b)(3) of this Subparagraph, at least four

360.8 (c)(5)(iii)(c)(2)

replicate measurements must be obtained for each sample and the initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values in samples obtained from upgradient wells during the first year.

(d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies:

(1) Samples collected to establish groundwater quality must be obtained and analyzed for the parameters specified in Subclause (b)(2) of this Subparagraph at least annually; and

(2) Samples collected to indicate groundwater contamination must be obtained and analyzed for the parameters specified in Subclause (b)(3) of this Subparagraph at least semi-annually.

(e) Elevation of groundwater surface at each monitoring well must be determined each time a sample is obtained.

(iv) Preparation, evaluation, and response.

(a) By the effective date of these regulations, the owner or operator must prepare an outline of a groundwater quality assessment program. The outline must describe a more comprehensive groundwater monitoring program (than that described in Subparagraphs 360.8(c)(5)(ii) and 360.8(c)(5)(iii)) capable of determining:

(1) Whether hazardous waste or hazardous waste constituents have entered the groundwater;

(2) The rate and extent of migration of hazardous waste or hazardous waste constituents in the groundwater; and

(3) The concentrations of hazardous waste or hazardous waste constituents in the groundwater.

(b) For each indicator parameter specified in Subclause 360.8(c)(5)(iii)(b)(3), the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored in accordance with Subclause 360.8(c)(5)(iii)(d)(2), and compare these results with its initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the Student's t-test at the 0.01 level of significance (see Appendix IV) to determine statistically significant increases (and decreases, in the case of pH) over initial background.

(c) (1) If the comparisons for the upgradient wells made under Clause (b) of this Subparagraph show a significant increase (or pH decrease), the owner or

operator must submit this information in accordance with Item 360.8(c)(5)(v)(a)(2)(ii).

(2) If the comparisons for downgradient wells made under Clause (b) of this Subparagraph show a significant increase (or pH decrease), the owner or operator must then immediately obtain additional groundwater samples from those downgradient wells where a significant difference was detected, split the samples in two, and obtain analyses of all additional samples to determine whether the significant difference was a result of laboratory error.

(d) (1) If the analyses performed under Subclause (c)(2) of this Subparagraph confirm the significant increase (or pH decrease), the owner or operator must provide written notice to the Commissioner -- within seven days of the date of such confirmation -- that the facility may be affecting groundwater quality.

(2) Within 15 days after the notification under Subclause (d)(1) of this Subparagraph, the owner or operator must develop and submit to the Commissioner a specific plan, based on the outline required under Clause (a) of this Subparagraph and certified by a qualified geologist or geotechnical engineer, for a groundwater quality assessment program at the facility.

(3) The plan to be submitted under Subclause 360.8(c)(5)(i)(d)(1) or Subclause (d)(2) of this Subparagraph must specify:

(i) The number, location, and depth of wells;

(ii) Sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility;

(iii) Evaluation procedures, including any use of previously gathered groundwater quality information; and

(iv) A schedule of implementation.

(4) The owner or operator must implement the groundwater quality assessment plan which satisfies the requirements of Subclause (d)(3) of this Subparagraph, and, at a minimum, determine:

(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the groundwater; and

(ii) The concentrations of the hazardous waste or hazardous waste constituents in the groundwater.

(5) The owner or operator must make his first determination under Subclause (d)(4) of this

Subparagraph as soon as technically feasible, and, within 15 days after that determination, submit to the Commissioner a written report containing an assessment of the groundwater quality.

(6) If the owner or operator determines, based on the results of the first determination under Subclause (d)(4) of this Subparagraph, that no hazardous waste or hazardous waste constituents from the facility have entered the groundwater, then he may reinstate the indicator evaluation program described in Subparagraph 360.8(c)(5)(iii) and Clause (b) of this Subparagraph. If the owner or operator reinstates the indicator evaluation program, he must notify the Commissioner in the report submitted under Subclause (d)(5) of this Subparagraph.

(7) If the owner or operator determines, based on the first determination under Subclause (d)(4) of this Subparagraph, that hazardous waste or hazardous waste constituents from the facility have entered the groundwater, then he:

(i) Must continue to make the determinations required under Subclause (d)(4) of this Subparagraph on a quarterly basis until final closure of the facility, if the groundwater quality assessment plan was implemented prior to final closure of the facility; or

(ii) May cease to make determinations required under Subclause (d)(4) of this Subparagraph if the groundwater quality assessment plan was implemented during the post-closure care period.

(e) Notwithstanding any other provision of this subpart, any groundwater quality assessment to satisfy the requirements of Subclause 360.8(c)(5)(iv)(d)(4) which is initiated prior to final closure of the facility must be completed and reported in accordance with Subclause 360.8(c)(5)(iv)(d)(5).

(f) Unless the groundwater is monitored to satisfy the requirements of Subclause 360.8(c)(5)(iv)(d)(4), at least annually the owner or operator must evaluate the data on groundwater surface elevations obtained under Clause 360.8(c)(5)(iii)(e) to determine whether the requirements under Clause 360.8(c)(5)(ii)(a) for locating the monitoring wells continues to be satisfied. If the evaluation shows that Clause 360.8(c)(5)(ii)(a) is no longer satisfied, the owner or operator must immediately modify the number, location, or depth of the monitoring wells to bring the groundwater monitoring system into compliance with this requirement.

(v) Recordkeeping and reporting.

(a) Unless the groundwater is monitored to satisfy the requirements of Subclause 360.8(c)(5)(iv)(d)(4), the owner or operator must:

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(6) Closure and post-closure.

The regulations in this paragraph apply to the owners and operators of all hazardous waste facilities subject to this subdivision except that the requirements of Subparagraphs (vi), (vii), (viii) and (ix) apply only to the owners and operators of disposal facilities unless otherwise required by the Commissioner.

(i) Closure performance standard.
The owner or operator must close the facility in a manner that: (a) minimizes the need for further maintenance, and (b) controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous waste constituents, leachate, contaminated rainfall, or waste decomposition products to the groundwater, or surface waters, or to the atmosphere.

(ii) Closure plan; amendment of plan.
(a) By the effective date of these regulations, the owner or operator must have a written closure plan, which shall be kept at the facility. This plan must identify the steps necessary to completely close the facility at any point during its intended life and at the end of its intended life. The closure plan must include, at least:
(1) A description of how and when the facility will be partially closed, if applicable, and ultimately closed. The description must identify the maximum extent of the operation which will be unclosed during the life of the facility, and how the requirements of Subparagraph 360.8(c)(6)(i) and the applicable closure requirements of Subparagraphs 360.8(c)(9)(iv), 360.8(c)(10)(v), 360.8(c)(13) (vi), 360.8(c)(12)(xvi), 360.8(c)(14)(iv), 360.8(c)(15)(iv), and 360.8(c)(16)(iv) will be met;
(2) An estimate of the maximum inventory of wastes in storage or in treatment at any given time during the life of the facility;
(3) A description of the steps needed to decontaminate facility equipment during closure; and
(4) A schedule for final closure which must include, as a minimum, the anticipated date when wastes will no longer be received, the date when completion of the final closure is anticipated, and intervening mile stone dates which will allow tracking of the progress of closure. (For example, the expected date for completing treatment or disposal of waste inventory must be included, as must the planned date for removing any residual wastes from storage facilities and treatment processes.)
(b) The owner or operator may amend his closure plan at any time during the active life of the facility. (The active life of the facility is that period during which

wastes are periodically received.) The owner or operator must amend his plan any time changes in operating plans or facility design affect the closure plan.

(c) The owner or operator must submit his closure plan to the commissioner at least 180 days before the date he expects to begin closure. The Commissioner will modify, approve, or disapprove the plan within 90 days of receipt and after providing the owner or operator and the affected public (through a newspaper notice) the opportunity to submit written comments. If an owner or operator plans to begin closure within 180 days after the effective date of these regulations, he must submit the necessary plans on the effective date of these regulations.

(iii) Time allowed for closure.

(a) Within 90 days after receiving the final volume of hazardous wastes, the owner or operator must treat all hazardous wastes in storage or in treatment, or remove them from the site, or dispose of them on-site, in accordance with the approved closure plan.

(b) The owner or operator must complete closure activities in accordance with the approved closure plan and within six months after receiving the final volume of waste. The commissioner may approve a longer closure period under Clause 360.8(c)(6)(ii)(c) if the owner or operator can demonstrate that: (1) the required or planned closure activities will, of necessity, take him longer than six months to complete, and (2) that he has taken all steps to eliminate any significant threat to human health and the environment from the unclosed but inactive facility.

(iv) Disposal or decontamination of equipment.

When closure is completed, all facility equipment and structures must have been properly disposed of, or decontaminated by removing all hazardous waste and residues.

(v) Certification of closure.

When closure is completed, the owner or operator must submit to the commissioner certification both by the owner or operator and by an independent, registered professional engineer that the facility has been closed in accordance with the specifications in the approved closure plan.

(vi) Post-closure care and use of property; period of care.

(a) Post-closure care must consist of at least:

(1) Groundwater monitoring and reporting in accordance with the requirements of Paragraph 360.8(c)(5); and

360.8 (c)(6)(vi)(a)(2)

(2) Maintenance of monitoring and waste containment systems as specified in Subparagraph 360.8(c)(5)(ii), 360.8(c)(10)(ii), 360.8(c)(10)(v), 360.8(c)(13)(vi), and 360.8(c)(12)(xvi), where applicable.

(b) The Commissioner may require maintenance of any or all of the security requirements of Subparagraph 360.8(c)(1)(iii) during the post-closure period, when:

(1) Wastes may remain exposed after completion of closure; or

(2) Short term, incidental access by the public or domestic livestock may pose a hazard to human health.

(c) Post-closure use of property on or in which hazardous waste remains after closure must never be allowed to disturb the integrity of the final cover, liner(s), or any other components of any containment system, or the function of the facility's monitoring systems, unless the owner or operator can demonstrate to the commissioner, either in the post-closure plan or by petition, that the disturbance:

(1) Is necessary to the proposed use of the property, and will not increase the potential hazard to human health or the environment; or

(2) Is necessary to reduce a threat to human health or the environment.

(d) The owner or operator of a disposal facility must provide post-closure care in accordance with the approved post-closure plan for at least 30 years after the date of completing closure. However, the owner or operator may petition the Commissioner to allow some or all of the requirements for post-closure care to be discontinued or altered before the end of the 30 year period. The petition must include evidence demonstrating the secure nature of the facility that makes continuing the specified post-closure requirement(s) unnecessary, e.g., no detected leaks and none likely to occur, characteristics of the waste, application of advanced technology, or alternative disposal, treatment, or re-use techniques. Alternately, the Commissioner may require the owner or operator to continue one or more of the post-closure care and maintenance requirements contained in the facility's post-closure plan for a specified period of time beyond the 30 year period. The Commissioner may do this if he finds there has been noncompliance with any applicable standards or requirements, or that such continuation is necessary to protect human health or the environment. At the end of the specified period of time, the commissioner will determine whether to continue or terminate post-closure care and maintenance at the facility. Anyone (a member of the public as well as the owner or operator) may petition the Commissioner for an extension or reduction of the post-closure care period based on cause. These petitions will be considered by the Commissioner at the time the post-closure plan is submitted and at five-year intervals after the completion of closure.

360.8 (c)(6)(vii)

(vii) Post-closure plan; amendment of plan.

(a) By the effective date of these regulations, the owner or operator of a disposal facility must have a written post-closure plan. He must keep this plan at the facility. This plan must identify the activities which will be carried on after final closure and the frequency of those activities. The post-closure plan must include at least:

(1) Groundwater monitoring activities and frequencies as specified in Paragraph 360.8(c)(5) for the post-closure period; and

(2) Maintenance activities and frequencies to ensure: (1) the integrity of the cap and final cover or other containment structures as specified in Subparagraphs 360.8(c)(10)(ii), 360.8(c)(10)(v), 360.8(c)(13)(vi) and 360.8(c)(12)(xvi), where applicable, and (2) the function of the facility's monitoring equipment as specified in Subparagraph 360.8(c)(5)(ii).

(b) The owner or operator may amend his post-closure plan at any time during the active life of the disposal facility or during the post-closure care period. The owner or operator must amend his plan any time changes in operating plans or facilities design affect his post-closure plan.

(c) The owner or operator of a disposal facility must submit his post-closure plan to the Commissioner at least 180 days before the date he expects to begin closure. The Commissioner will modify or approve the plan within 90 days of receipt and after providing the owner or operator and the affected public (through a newspaper notice) the opportunity to submit written comments. The plan may be modified to include the security equipment maintenance under Clause 360.8(c)(6)(vi)(b). If an owner or operator of a disposal facility plans to begin closure within 180 days after the effective date of these regulations, he must submit the necessary plans on the effective date of these regulations. Any amendments to the plan under Clause (b) of this Subparagraph which occur after approval of the plan must also be approved by the Commissioner before they may be implemented.

(viii) Notice to county clerk.

Within 90 days after closure is completed, the owner or operator of a disposal facility must submit to the county clerk and to the Commissioner a survey plat indicating the location and dimensions of landfill cells or other disposal areas with respect to permanently surveyed benchmarks. This plat must be prepared and certified by a professional land surveyor. The plat filed with the county clerk must contain a note, prominently displayed, which states the owner's or operator's obligation to restrict disturbance of the site as specified in Clause 360.8 (c)(6)(vi)(c). In addition, the owner or operator must submit to the commissioner and to the county clerk a record of the type,

360.8 (c)(6)(viii)

location, and quantity of hazardous wastes disposed of within each cell or area of the facility. For wastes disposed of before these regulations were promulgated, the owner or operator must identify the type, location, and quantity of the wastes to the best of his knowledge and in accordance with any records he has kept.

(ix) Notice in deed to property.
The owner of the property on which a disposal facility is located must record, in accordance with the State law, a notation on the deed to the facility property -- or on some other instrument which is normally examined during title search -- that will inperpetuity notify any potential purchaser of the property that: (1) the land has been used to manage hazardous waste, as described in the surveying plat and other information filed with the county clerk and the commissioner pursuant to Subparagraph (viii) of this Paragraph, and (2) its use is restricted under Clause 360.8(c)(6)(vi)(c).

(7) Financial requirements.

The regulations in this Paragraph apply to the owners and operators of all hazardous waste facilities subject to this Subdivision except that the requirements of Subparagraph (ii) applies only to the owners and operators of disposal facilities and the requirements of this Paragraph do not apply to facilities owned and operated by the state or federal government.

(i) Cost estimate for facility closure.
(a) By the effective date of these regulations, each facility owner or operator must have a written estimate of the cost of closing the facility in accordance with the requirements in Subparagraphs 360.8(c)(6)(i) through 360.8(c)(6)(v) and applicable closure requirements in Subparagraphs 360.8(c)(9)(iv), 360.8(c)(10)(v), 360.8(c)(13)(vi), 360.8(c)(12)(xvi), 360.8(c)(14)(iv), 360.8(c)(15)(iv), and 360.8(c)(16)(iv). The owner or operator must keep this estimate, and all subsequent estimates required in this paragraph, at the facility. The estimate must equal the cost of closure at the point in the facility's operating life when the extent and manner of its operation would make closure the most expensive, as indicated by its closure plan (see Subparagraph 360.8(c)(6)(ii)).
(b) The owner or operator must prepare a new closure cost estimate whenever a change in the closure plan affects the cost of closure.
(c) On each anniversary of the effective date of these regulations, the owner or operator must adjust the latest closure cost estimate using an inflation factor derived from the annual Implicit Price Deflator for Gross National

piled, unless that area has been decontaminated sufficiently to ensure compliance with Clause 360.8(c)(1)(v)(b).

(12) Secure landburial facilities.

The regulations in this Paragraph apply to owners and operators of facilities subj.ct to this Subdivision that dispose of hazardous waste in landfills. A waste pile used as a disposal facility is a secure landburial facility and is governed by this Paragraph.

(i) Site characteristics

(a) The soil beneath the facility shall have a hydraulic conductivity of 10^{-5} centimeters per second or less and shall be subject to the approval of the Department.

(b) No waste shall be closer than ten feet to an aquifer or bedrock.

(c) No facility shall be located over groundwater recharge areas serving public water supplies.

(d) Facilities shall be located at an elevation not less than five feet above a flood plain unless provisions have been made to prevent the encroachment of flood waters.

(e) All fill areas or excavations shall terminate no closer than fifty feet from the boundary lines of the property on which the secure landburial facility is operated.

(f) The required horizontal separation between deposited hazardous waste and any surface waters shall be determined for each secure landburial facility by reference to soil attenuation characteristics, drainage, and natural or manmade barriers.

(ii) Design requirements.

(a) An impermeable barrier consisting of a synthetic liner and/or natural material of approved composition and thickness and having a hydraulic conductivity of 10^{-7}centimeters per second or less shall be placed or constructed between any deposited hazardous wastes and the surrounding soil and shall be subject to the approval of the Department.

(b) Leachate collection and treatment facilities shall be provided and shall be properly maintained and monitored. Leachate levels in the secure landburial facility shall not exceed the level specified in the permit to operate.

(c) Run-on must be diverted away from the active portions of a secure landburial facility. Run-off from active portions of the facility, including storage and handling areas, shall be collected in a holding area, and if the department determines it to be necessary, analyzed and treated before discharge, which discharge shall be consistent with ECL Article 17. If this run-off is a hazardous waste under Part 366 of this

Title, it must be managed as a hazardous waste in accordance with all applicable requirements of Parts 360, 365, and 366 of this Title.

(d) An impermeable cap shall be placed or constructed over the top of landfill cells within two months of their completion in such a way as to prevent water from entering the cell. The impermeable cap shall consist of a synthetic or natural material of acceptable composition and thickness and having a hydraulic conductivity of 10^{-7} centimeters per second or less and shall be subject to approval of the Department.

(e) Daily cover shall be placed upon all exposed solid waste prior to the end of each operating day.

(f) Completed cells shall have a gas venting system.

(g) Soil cover integrity, slopes, cover vegetation, drainage structures, groundwater monitoring facilities and gas venting structures established pursuant to a permit shall be maintained throughout the active life of the landfill and the post-closure care period.

(h) Secure landburial facilities containing hazardous waste subject to dispersal by wind must be covered or otherwise managed to control such wind dispersal.

(iii) Waste acceptance and disposal requirements

(a) A secure landburial facility shall receive only those classes of wastes approved in writing by the Department.

(b) Ignitable or reactive waste must not be placed in a secure landburial facility, unless the waste is treated, rendered, or mixed before or immediately after placement in the secure landburial facility so that (1) the resulting waste mixture, or dissolution of material no longer meets the definition of ignitable or reactive waste under Subdivisions 366.3(b) or 366.3(d) of this Title, and (2) Clause 360.8 (c)(1)(v)(b) is complied with.

(c) Incompatible wastes, or incompatible waste and materials (see Appendix V for examples) must not be placed in the same landfill cell, unless Clause 360.8(c)(1)(v)(b) is complied with.

(d) Bulk or non-containerized liquid waste or waste containing free liquids must not be placed in a secure landburial facility.

(e) A container holding liquid waste or waste containing free liquids must not be placed in a secure landburial facility, unless:

(1) The container is designed to hold liquids or free liquids for a use other than storage, such as a battery or capacitor; or

(2) The container is very small, such as a ampule.

360.8 (c)(12)(iii)(f)

(f) An empty container must be crushed flat, shredded, or similarly reduced in volume prior to disposal in a secure landburial facility.

(iv) Surveying and recordkeeping.

Secure landburial facilities shall be totally fenced and secured to prevent public access. The owner or operator must maintain, on a map, the exact location and dimensions, including depth, of landfill cells with respect to permanently surveyed benchmarks. Completed sections of the site shall be clearly marked by permanent monuments inscribed with warnings of the hazardous wastes contained in the section. Records containing description and quantities of hazardous wastes within the site, together with location designations for specific waste types correlated with said monuments, shall be maintained by the facility operator and filed with the department upon completion of the facility, or any portion thereof.

(v) Closure and post-closure.

(a) The owner or operator must place a final cover over the secure landburial facility, and the closure plan under Subparagraph 360.8(c)(6)(ii) must specify the function and design of the cover. In the post-closure plan under Subparagraph 360.8(c)(6)(vii), the owner or operator must include the post-closure care requirements of Clause (d) of this Subparagraph.

(b) In the closure and post-closure plans, the owner or operator must address the following objectives and indicate how they will be achieved:

(1) control of pollutant migration from the facility via groundwater, surface water, and air;

(2) control of surface water infiltration, including prevention of pooling; and

(3) prevention of erosion.

(c) The owner or operator must consider at least the following factors in addressing the closure and post-closure care objectives of Clause (b) of this Subparagraph.

(1) Type and amount of hazardous waste and hazardous waste constituents in the secure landburial facility.

(2) The mobility and the expected rate of migration of hazardous waste and hazardous waste constituents;

(3) Site location, topography, and surrounding land use, with respect to potential effects of pollutant migration (e.g., proximity to groundwater, surface water and drinking water sources);

(4) Climate, including amount, frequency, and pH of precipitation;

(5) Characteristics of the cover including material, final surface contours, thickness, porosity and permeability, slope, length of run of slope, and type of vegetation on the cover; and

(6) Geological and soil profiles and surface and subsurface hydrology of the site.

(d) In addition to the requirements of Subparagraph 360.8(c)(6)(vi), during the post-closure care period, the owner or operator of a secure landburial facility must:

(1) Maintain the function and integrity of the final cover as specified in the approved closure plan;

(2) Maintain and monitor the leachate collection, removal and treatment system (if there is one present in the secure landburial facility) to prevent excess accumulation of leachate in the system;

(3) Maintain and monitor the gas collection and control system (if there is one present in the secure landburial facility) to control the vertical and horizontal escape of gases;

(4) Protect and maintain surveyed benchmarks; and

(5) Restrict access to the secure landburial facility as appropriate for its post-closure use.

(13) Land treatment

The regulations in this Paragraph apply to the owners and operators of all hazardous waste land treatment facilities subject to this Subdivision.

(i) General operating requirements.

(a) Hazardous waste must not be placed in or on a land treatment facility unless the waste can be made less hazardous or non-hazardous by biological degradation or chemical reactions occurring in or on the soil.

(b) Run-on must be diverted away from the active portions of a land treatment facility.

(c) Runoff from active portions of a land treatment facility must be collected.

(ii) Waste analysis.

In addition to the waste analyses required by Subparagraph 360.8(c)(i)(ii), before placing a hazardous waste in or on a land treatment facility, the owner or operator must:

(a) Determine the concentrations in the waste of any substances which exceed the maximum concentrations contained in Table I of Subdivision 366.3(e) of this Title that cause a waste to exhibit the EP toxicity characteristic;

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